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York Neuroimaging Centre

THE UNIVERSITY of York

MEG

Operator Guidelines and Reference

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1. Introduction to the MEG Operator Guidelines

1.1. Overview

The MEG Operator Guidelines are designed to be a comprehensive guide to operating the MEG scanner. The Introduction defines the rules of practice in the MEG scan suite, the roles and responsibilities of operators, and advice on participant handling. There then follows specific guidelines for the pre-scan set up period and then a comprehensive guide to the scanning process. In the appendicies are extra information needed for non-typical scan setups and a troubleshooting guide, should you have a problem and need quick specific advice.

1.2. Rules of the MEG suite

The following rules must be adhered to in the MEG suite to ensure the safe running of experiments, and reduce the risk of common infections and hazards.

1. The work areas must be kept clean and tidy.
2. No smoking, eating or drinking in the MEG scan suite.
3. No cosmetics should be applied in the MEG scan suite
4. Hygenic / protective paper must **always** be used on the chair in MEG, and **always** changed after each particpant.
5. Anti-bacterial waterless hand-scrub must be used **before** and **after** contact with participants.
6. Laboratory gloves must be worn when appropraite.
7. Objects that need mouth manipulation must not be used. The operator should not come into contact with any equipment that has been in a participants mouth.
8. After each session, anti-bacterial wipes must be used to clean the parts of the MEG suite that the participant has had direct contact with.
9. Any blankets or sheets that have been used during an aquisition should go to the laundry after use.
10. Appropriate footwear must be worn (no open-toed sandals or open-weave fabric shoes).
11. Manual operations must be performed with due reguard to any potential hazards, and care must be taken to aviod injury. (i.e. Use both hands when moving the back of the chair, the MEG dewar and MEG cage).
12. Any supplimentary cables that are required for a study **must not** trail on the floor of the MEG scan suite. Supplementary cables must be wired in a manner which keen the MEG scan suite floor free of any obstacles.
13. The Operator must always be familiar with evacuation procedures.
14. The Operator must always be familiar with the various MEG alarms, and the respective implication of any specific alarm being activated.

1.3. MEG Operator Roles and Responsibilities

The roles and responsibilities of an operator are as follows:

1. An MEG operator is responsible for ensuring that the rules of the MEG scan suite are adhered to by all present in the MEG scan suite during an experiment.
2. An MEG operator runs a specific acquisition procedure that is agreed at the project's protocol feasibility scan. This includes:
    a. Putting the participant into the scanner.

b. Running MEG software for data acquisition.

c. Communicating with the participant.

d. Helping the participant out of the MSR at the end of the acquisition.

e. Cleaning the MSR, and returning the scan suite to its default state.

f. Informing the investigator of any problems with software/hardware.

g. Troubleshooting basic faults holding up the experiment.

h. Reporting unresolved faults to reception, and requesting that reception contact a member of YNiC staff.

3. Operating the scan includes all the pre-scan set up procedures necessary for the specific study. This includes:

   a. Making sure that MEG is set up according to the requirements supplied in the study's Experimental Setup sheet.

   b. Checking that the appropriate trigger setup is in place, and that the trigger line is zeroed by running the "ParallelPortRest" program.

   c. Checking that the stimuli (i.e. auditory / visual / somatosentory) are correctly set up for a specific study.

   d. Setting up the magnetically-shielded room (MSR) for data acquisition.

   e. Ensuring that the participant has completely de-metalled before they enter the MSR.

   f. Informing the investigator of any problems with software/hardware.

   g. Troubleshooting basic faults holding up the set up of the experiment.

   h. Reporting unresolved faults to reception, and requesting that reception contact a member of YNiC staff.

4. An MEG operator has ultimate responsibility for ensuring that the participant has completed and understood the Full YNiC Consent Forms. These must always be completed and signed off by the Operator.

5. An MEG operator is responsible for logging every scan they record on the MEG scanner, and also logging any error that may occur.

6. An MEG operator **is not** responsible for running the experimental stimuli.

7. An MEG operator is not responsible for fixing all possible faults in the MEG scan suite. However, if there is a fault that they cannot fix, they must report it to reception, and request for a member of YNiC staff to attend the fault.

8. An MEG operator is responsible for making sure that investigators leave MEG at the end of their session and do not over-run into time allocated to other people. This may involve not starting the last run of an investigators study if it will cause the session to over-run.

   N.B. You should inform investigators that should their study overrun due to the investigator being un-prepared, then the investigator will be penalized. The amount of time that the investigator overruns by will be rounded up to the nearest 15 minutes, doubled, and then subtracted from their REC alloted MEG time allowance. And if there is a subsequent study that has been inconvenienced, an equivalent amount will additionally be taken from the overrunning groups REC alloted MEG time, and added to the subsequent studies REC alloted MEG time allowance. Thus effectively fining the transgressing study quadruply for their overrun.

9. One MEG operator each day will perform a Daily Quality Assurance test (DQA). If you are the first operator of the day you will be expected to do a DQA before the MEG booking. You are advised to check the bookings calendar after noon on the day preceding your scan to see if you will be the first operator of the following

day. If you are the first operator of the day, you are advised to arrive 30 minutes early, so that you may do the DQA and also have time to prepare for the scan. Once you have done the DQA, you will need to report this to reception, and ask them to retrospectively record this in the database.

1.4. Participant Handling

Before scanning, it is essential that the participant is fully relaxed in the MEG scanner. This is particularly important if it is the participant's first scan. There are two sources of potential problems that can occur from ill at ease participants. Firstly, an uncomfortable participant will wriggle about to make him or herself more comfy, which will generate muscle artefacts amongst other things. Secondly, if the participant is anxious, responses to your sensory or cognitive paradigm will be masked, or at the least attenuated by their discomfort (be it by reduced attention or by cortical responses to anxiety). Also, it is vital to ensure that there are no artefacts generated by the participant wearing any metal objects. The following procedures ought to minimise the above concerns.

Before putting a participant in the scanner, familiarise them with the scan room and the scanner. Explain that MEG records responses passively, so the only direction of activity is from the brain to the recording equipment. The reason for the shielded room is to minimise interference from outside objects, not to stop magnetic fields from the scanner escaping. An example you may like to use is that the size of the magnetic fields we record from the brain are equivalent to the fields that would be generated by a car being driven 1 mile away. Hence it is vital to reduce any external interference. At all times whilst they are in the scanner, they can be heard via the intercom and observed via the camera. And at any point during the scan, if they are uncomfortable with the procedure they are able to request that it is aborted.

It is essential to establish intercom contact as soon as you have shut the shielded room door after digitization. This is principally to put the participant at ease; however, it is also necessary to establish that the intercom is working properly. So, say hello, ask them if they are comfortable, then tell them that you are going to spend a couple of minutes setting up the acquisition parameters, and that you will speak to them again before the recording begins. Un-explained silences typically make participants nervous, and if they are nervous already, it's just going to make things worse.

Once you have finalised your acquisition parameters, check that you can see responses from the participant and that there are no artefacts. After performing these checks, assuming that they are normal tell the participant that everything looks great, and that you will start the scan. (If everything is not normal you will have to ask them to remove the offending metal items.) Just before starting scanning, check the participant is still comfortable and happy to proceed. If they are, tell them to sit still and that you will speak to them in x minutes at the end of the run.

When the run finishes. Speak to your participant again. Tell them that everything went well, and to relax – but stay seated / supine until the next run / someone comes in to get them out of the scanner. Again, if there is going to be another set up period before another run, tell them you will speak to them in 2 minutes or whatever. If you are going to take a while setting up, you may want to open up the scan room door to give them some air.

As a general rule, when speaking to the participant, try to sound relaxed and in control. The impression you give will often dictate how they feel during the scan. If you're worried, then they will be worried. However, if you are relaxed and happy, there is a good chance that they will be too.

2. Working Out of Normal Office Hours (8am - 6pm)

2.1. You Must Not Work Alone At YNiC

There must always be at least 2 people in YNiC at any one time. One person must be a key holder. There can be no exception to this under any circumstances.

Please let someone know where you are within the building, what time they can expect you back and what you are doing. Give them the Security telephome number (434444) in case you do not arrive back when expected. They can then ring Security to report your absence. Note the position of the panic alarms in MRI and MEG.

The following numbers are very useful and should be kept at hand whilst in the YNiC building:

1. YNiC On-Call: 07908 614895

2. Security: ext. 4444

3. Emergency: ext. 3333 OR 9-999

If you hear a continuous high pitched tone, it is probably the panic alarm. Please go to the reception area and look at the monitor on the wall behind the reception desk. This will tell you where the panic alarm has been activated. Attend the site of the panic and, if necessary, contact the emergency services.

If you hear a loud continuous siren sounding it will probably be a Fire Alarm.

2.2. When You Hear The Fire Alarm

Immediately leave the building and tell others to do likewise. Close the doors behind you.

Use the nearest and quickest safe route to outside, there are at least four; one by the MRI control room, one by the entrance to MEG, one at the end of the open plan area nearest the Biocentre reception, and one at the YNiC main reception.

When outside, got to the place of Assembly (in car park) and stay there until the Fire Service has completed an evacuation check of the building. Report to the fire marshall. If you know of anyone still to be inside, tell the fire marshall who will inform the Fire Service.

2.3. Your Place of Assembly

Is in the car park outside YNiC.

2.4. If You Discover a Fire

Raise the fire alarm and activate fire bells at the nearest break glass point.

Telephone emergency services, internal ext. 3333 OR ring 9-999, advising central control of the location of the fire.

Tell the emergency services that a MRI MAGNET and CRYOGENS are on site and that ADVICE MUST BE SOUGHT BEFORE ENTERING the building.

2.5. Use Of Fire Equipment

Do **NOT** take any risks.

Check emergency exit routes and locations of alarms. It could save your life and others.

2.6. Health Safety and Welfare Policy for Working out of Normal Hours at YNiC

Ensure that you make yourself familiar with the University of York “Health, Safety and Welfare Policy” (http://www.york.ac.uk/admin/hsas/policy.html) and the MEG and MRI Operating Policies of YNiC.

3. Pre-Scan: Entry Into MEG

3.1. Entry Procedure

1. Open the doors into MEG and turn off the alarm.
2. Turn lights on.

Warning

If O_2 alarm (shrill, loud beeping) is sounding, **you must leave the MEG Scan Suite**

Leave MEG immediately and notify reception, who will contact a member of YNiC staff.

3.2. Safety Checklist

Check all of the following:

1. The whiteboard and log book for information regarding safety issues or problems in MEG.
2. That both temporary MEG fobs are hanging up on the wall. If any are missing, inform reception.
3. That the aluminium Helium dewars in the storage area are safe (i.e. no gas escaping and making a hissing noise). The helium storage area is shown in Figure 3.1. Doors to this storage area must remain closed during scanning.

   If there is gas, please contact reception, who will contact a member of YNiC staff.

Figure 3.1. Helium Storage Area.

4. Are any alarms going off (O_2, helium dewar lid or patient)?

   a. If it is the O_2 alarm, **Do Not Enter MEG**

Leave immediately and notify reception, who will immediately alert a member of YNiC staff

b. If it is the helium lid alarm (intermittent beeping from the DAS), you don't need to leave the MEG Scan Suite.

   Contact reception, who will contact a member of YNiC staff. The staff member will remove and replace the lid on the dewar.

c. If it is the patient alarm, reset at the unit attached to the wall near megmap.

5. Check O_2 level on blue box inside stimulus delivery room. The O_2 level should be about 20 %. The "metal" ball should be floating in the column.

Figure 3.2. O_2 Monitor.

*If it has fallen to a dangerously low-level **(i.e. below 18 %)**, the alarm should be sounding. If the level is below **18 %** and the the alarm isn't sounding, leave MEG immediately and notify reception, who will contact a member of YNiC staff.*

3.3. MEG Scan Suite Equipment

Before you proceed to setting up the Magnetically Shielded Room, have a quick check of the MEG Scan Suite, and check that all the items of equipment in Figure 3.3) and Figure 3.4) are present.

Figure 3.3. MEG Scan Suite Equipment Consoles

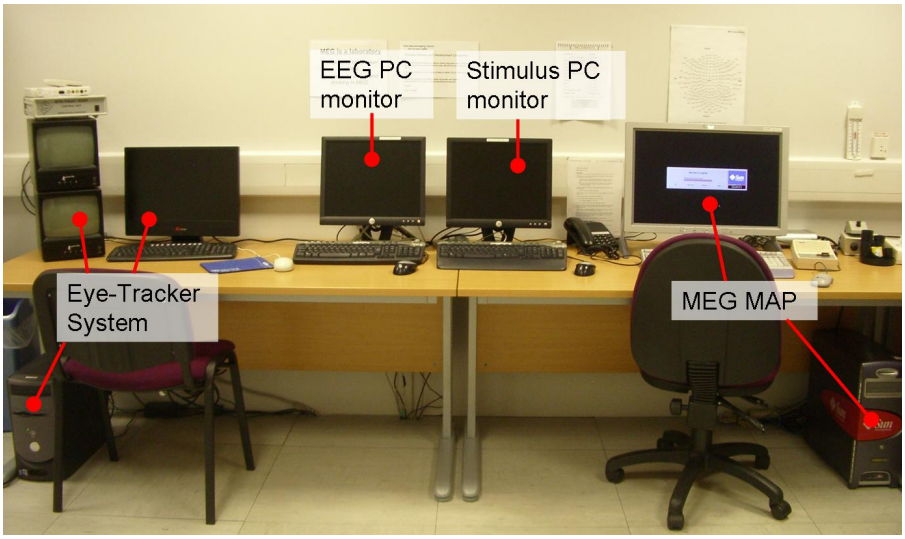
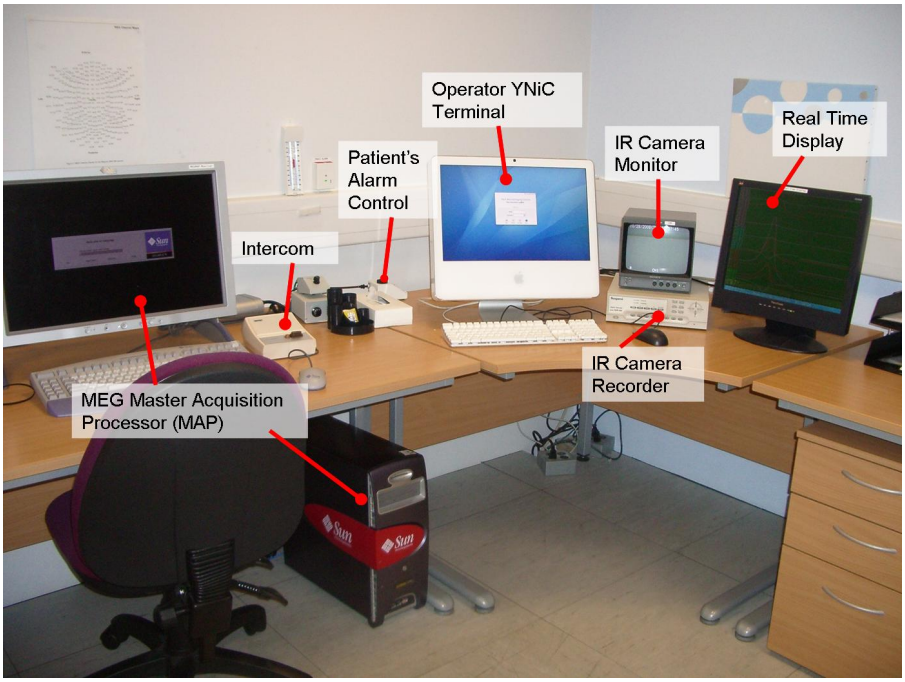


Figure 3.4. MEG Scan Suite Operator Consoles



4. Pre-Scan: MSR (Magnetically Shielded Room) Set Up

Before You Start

Familiarize yourself with the Experimental Setup sheet. Information for each study can be found in the MEG study setup folder, near megmap. For setting up the MSR you will need to know the following from the Experimental Setup sheet:

- What will the participant's position be: Supine or seated?
- Does the experiment require a visual display?

4.1. Room Lighting

1. Turn the lights on in the MSR by pressing the light switch located on the wall outside the MSR beside the door (Figure 4.1).
2. In order to dim the lights in the MSR, use the brightness (black) knob to dim the light.

Figure 4.1. MSR Light Control Switch.

4.2. Door Operation

4.2.1. Opening the Door

1. Press (until the air locks release) then quickly release the Open/Close button (Figure 4.2).
2. Pull the door open.

4.2.2. Closing the Door

1. Push the door up to the door frame as far as possible.
2. Press (until the air locks activate) then quickly release the Open/Close button (Figure 4.2) to seal the door.

Figure 4.2. MSR Door Open/Close Control

Should the door not open, it is likely that there is a problem with the pneumatics. In which case use the emergency door opening procedures outlined below. If you have to use the emergency door opening procedure before a scan, please inform reception, who will contact a member of YNiC staff. The door should be checked before you put a participant in the scanner.

4.2.3. Emergency Door Opening

1. If the door cannot be opened in the normal mode, press the Emergency-Off (Red) button located on the door outside and the inside of the MSR (Figure 4.3). Pressing the Emergency-Off button should release the pneumatic lock and allow you to move the door freely.

2. If using the Emergency-Off Button does not solve the failure, you will need to un-lock the door manually. Insert the Emergency Door Key in both the upper and lower emergency unlock keyholes and turn anti-clockwise if you're outside the MSR, or clockwise if you're inside the MSR (Figure 4.4). This will manually release the door locks. Keys and keyholes are located on both sides of the MSR door.

Should you need to manually open the door with the Emergency Door Keys, you will need to reset the door locks. To do this, use the Emergency Door Key to return the lock to its original position, and then manually pull the lock out until it click into position (Figure 4.5).

Figure 4.3. MSR Door Emergency Control

Figure 4.4. Emergency Opening of the MSR Door

Figure 4.5. Emergency Reset of the MSR Door

4.3. Moving the Chair and Bed

The bed can move from side-to-side or front-to-back. The position of the bed can be controlled using the break unit mounted on the wall and maintained with the two floor locks. The wall unit (Figure 4.7 and Figure 4.8) determines in which direction the bed will move. A schematic of the bed / chair, showing all its major functions, may be seen in Figure 4.6.

Figure 4.6. MEG Bed / Chair Schematic Diagram.

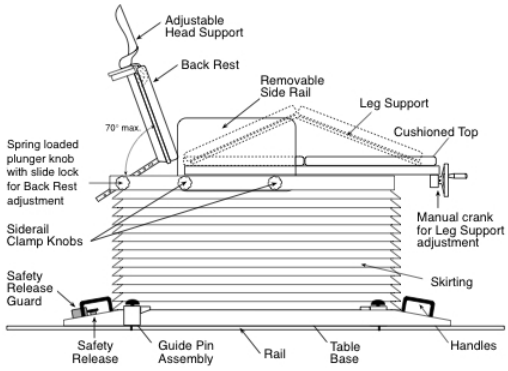
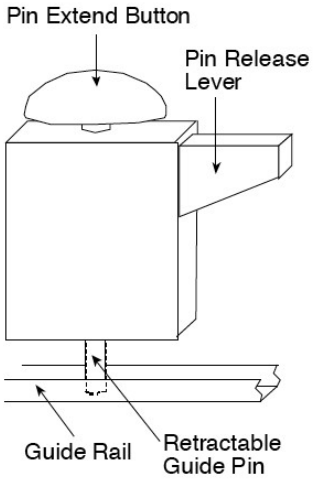


Figure 4.7. MEG Bed Wall Control: Lateral movement.

Figure 4.8. MEG Bed Wall Control: Longitudinal movement.

Before a scan is started, check that the brakes are locked down onto the guide rail. To lock the break, press the “Pin Extend” button, see Figure 4.9. The This check can be done by trying to physically move bed; if the bed won't move, it is locked down.

Figure 4.9. MEG Bed / Chair Break.



In a seated experiment the bed should be as close to the dewar as possible (i.e. it should be as far towards as the guide rail will allow without the bed moving outside the edge of the guide rail).

In a supine experiment the bed should be located as close to the equipment room (wave guide) wall as possible, without touching the wave guides.

Caution

N.B. The bed must be locked down before there is a participant in the scanner. To avoid injuring the participant's head and/or neck, the bed must not be moved when the participant's head is inside the dewar. Make corrections to the position of the bed or dewar before the participant is inside the dewar.

4.4. Chair and Bed Adjustments

The chair is a pneumatic-hydraulic unit and there may be some delay when turning controls from the unlocked to the locked position, or when making chair adjustments. Refer to Figure 4.10 when adjusting the backrest.

4.4.1. Chair Adjustments (Seated Position)

Before adjusting the chair, move it into position:

1. Slide the chair as far towards the dewar as the guide rail will allow.
2. Lock the chair putting the Brake to Position 2 (side-to-side).

4.4.1.1. Backrest Tilt

Warning

The backrest is heavy.

1. Support the back of the chair with one hand.
2. While still supporting the backrest, pull out the black knob at the base of the left side of the chair.
3. Keeping the knob out, tilt the backrest until completely raised.
4. Release the knob making sure the back rest is locked.

4.4.1.2. Backrest Height Adjustments

Warning
The backrest is heavy.

1. The handles at the back of the chair can adjust the height of the back/neck rest. Clockwise turns tighten, anti-clockwise turns loosen.
2. Support the back of the chair with one hand.
3. With the other hand, loosen the two handles (anti-clockwise).
4. With *both* hands, pull-up the backrest to the desired height. While still supporting the backrest, use one hand to tighten the two handles (clockwise) to secure.

4.4.1.3. Knee Support

1. Turn the hand wheel located at the chair front-end to raise/lower knee rest.
2. Clockwise turns raise, anti-clockwise turns lower.

4.4.1.4. Head Rest (Polhemus)

1. Slot the head rest into place on the metal bar.
2. The base of the head rest can be adjusted with the wheel nearby. If the head rest is not locking down correctly, you may need to tighten the pin in the metal bar.
3. To remove the headrest, pull up the lever that is located to its right hand side.
4. This lever can also be used to set the headrest at a certain angle. First physically orientate the headrest to the desired angle and then push the lever downwards to hold it in place.

4.4.2. Bed Adjustments (Supine Position)

Before adjusting the chair, move it into position:

1. Slide the chair as far away from the dewar (close to the waveguides) as the guide rail will allow.
2. Lock the chair putting the Brake to Position 2 (side-to-side). N.B. Only one of the locks will be in the guide rail.

4.4.2.1. Backrest Height Adjustments

Warning
The backrest is heavy.

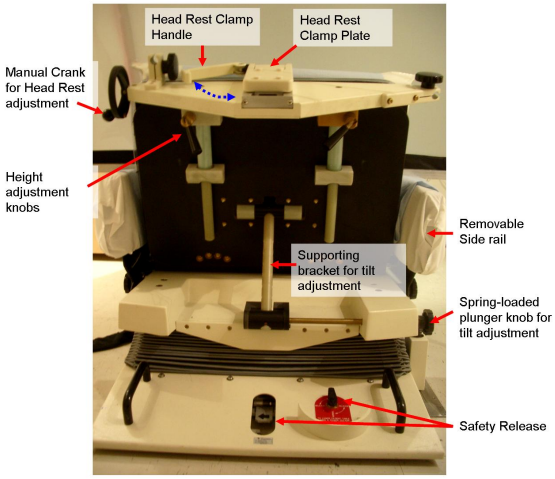
1. The handles at the back of the chair can adjust the height of the back/neck rest. Clockwise turns tighten, anti-clockwise turns loosen.
2. Support the back of the chair with one hand.
3. With the other hand, loosen the two handles (anti-clockwise).
4. With *both* hands, pull-down the backrest to the lowest position. Tighten the two handles (clockwise) to secure.

4.4.2.2. Backrest Tilt

Warning
The backrest is heavy.

1. Support the back of the chair with one hand.
2. While still supporting the backrest, pull out the black knob at the base of the left side of the chair.
3. Keeping the knob out, tilt the backrest until completely lowered.
4. Release the knob making sure the back rest is locked.

Figure 4.10. MEG Bed Backrest



4.4.2.3. Knee Support

- Turn the hand wheel located at the chair front-end to lower the knee rest until completely flat.

  N.B. Make sure that the handle for the knee support does not touch the waveguide.

Figure 4.11. MEG Bed Knee Support

4.5. Chair / Bed Height Adjustment

In preparation for the scan, the chair / bed needs to be moved to suitable height so that the participant can get on to it with ease.

A control pad adjusts the height of the bed. To raise the bed press either "up" () buttons must be pressed. Press *both* to increase speed. To lower the bed press either "down" () button.

Figure 4.12. MEG Bed Height Control

For a seated experiment start with the bed at ground level.

For a supine experiment start with the bed at a height roughly equivalent to the height of the dewar helmet. Leave the step-stool by the bed, so that the participant may use it to help them get onto the bed.

The height fo the bed will need to be adjusted when a participant is in the scanner. Remember to inform the participant before changing the height of the bed, and make sure that their head is in a safe position before starting to move the chair / bed.

4.6. Chair Hygiene

Make sure that there is blue hygienic / protective paper on the bed and on the cushions. This should be fresh paper for each participant. If there is paper, but it has already been used, replace it with fresh paper from the shelves in the MSR.

4.7. Beanbag

The beanbag is a body-support mattress that adjusts to individual participant's body shapes. This helps to minimize the participant's body movement. It is not routinely used now that there is a soft mattress. However, should you need to use it, you should know the following:

1. The air inside the beanbag can be put in by pressing the valve, or taken out using the air pump.
2. The beanbag must be flattened out after each participant.

4.8. Positioning the MEG Dewar

Before the scan, you must move the scanner into either the seated or supine position, see Figure 4.13 and Figure 4.14. The movement controls for the dewar are the black buttons located on the dewar handles on both sides. Either side can be used.

4.8.1. To Move Backwards / Forwards:

1. Use the outer buttons

2. Keeping the button pressed, push the handle in the desired direction.

4.8.2. To Tilt the dewar Up / Down:

1. Use the inner buttons
2. Keeping the button pressed, push the handle upwards to tilt clockwise / downwards to tilt anti-clockwise.
3. Tilt the dewar clockwise for supine position; anti-clockwise for seated position.

Figure 4.13. MEG Sensor Seated.

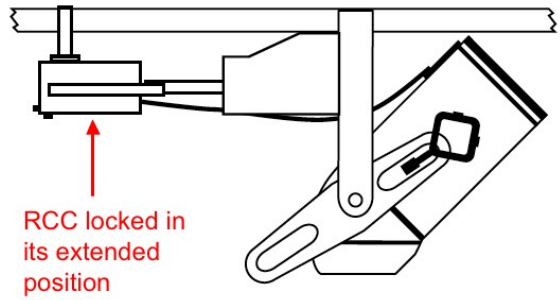
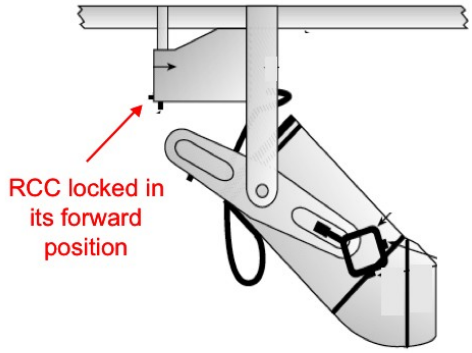


Figure 4.14. MEG Sensor Supine.



4.9. Moving the RC Cage

You will not have to move the RC cage during the set up period. However, before the recording begins, the RC cage must be moved as far away from the dewar as possible. The position changes depending upon the recording position. This will prevent any electrical contamination of the data that may be caused by the RC cage.

1. To move the cage away from the dewar when recording in the seated position, slide the cage as close to the back of the rail as possible, see Figure 4.13.
2. To move the cage towards the waveguide wall when recording in the supine position, slide the cage as close to the front of the rail as possible, see Figure 4.14.

4.10. Participant Monitoring Inside the MSR

Caution

Participant must **always** be monitored via the Video Display Monitor when running a study. Participants must be made aware that there is a camera and an intercom for communication. **The participant must be observed at all times whilst they are in the MSR**.

The operator can monitor and communicate with the participant inside the MSR using:

1. Voice Intercom / Flat Speaker.
2. Video Camera, with Infrared lighting for video in the darkness.
3. Video Display at the operator console.

Check that each of these monitors is operational during the scan set up.

4.10.1. Voice Intercom

The intercom is used to communicate and listen to a participant inside the MSR (Figure 4.15). The Intercom Box is located at the acquisition workstation megmap (Figure 3.4). The following are instructions to operate the intercom:

1. The Intercom is alsways on. To listen to a participant inside the MSR, turn the volume control knob on the right hand side of the Intercom Box to increase the volume.
2. To speak to a participant in the MSR press the TALK button located beside the power button of the Intercom (Keep the button pressed to talk to the participant.)
3. To check that the intercom is working properly, open the MSR door, press the TALK button, and turn up the volume so that you get feedback. This indicates that the intercom is working.

Figure 4.15. MEG Intercom.

4.10.2. Video Display Monitor

This is located beside the Real Time Display monitor. To operate, press the Off / On switch on the front panel.

4.10.3. MSR IR Camera

This is mounted on the portable table inside the MSR. The following are instructions to operate the camera:

1. Switch the camera on. The switch is located on the somatosensory unit in the Stimulus Delivery room (Figure 4.16).

2. Position the camera table so that the participants face can be seen on the Video monitor.

Figure 4.16. IR Camera Switch

4.11. Other Final Checks

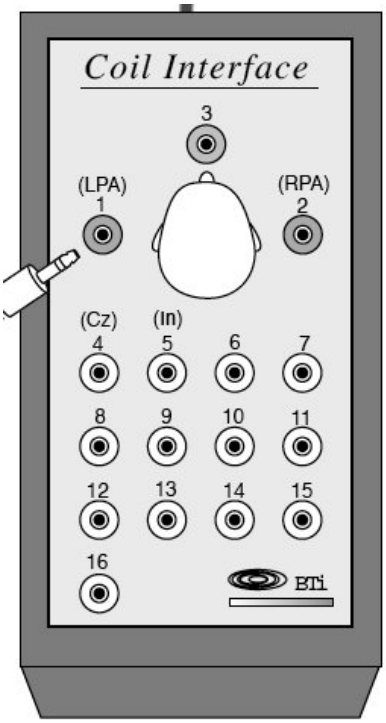
4.11.1. O_2 Monitoring

The O_2 Monitor is clear tube on the right of the door as you enter the MSR. Make sure that the tube is up against the ceiling.

4.11.2. Check Head Coils

Check the head coils for cracks in their coating, protruding wires etc. The head coils will be hanging from the Head Coil Box on the nearside of the MEG dewar, see (Figure 4.17). If a coil is broken, it should be replaced with a new one, which may be found in the grey cabinet labelled “1”.

Figure 4.17. Head Coil Interface Box.



4.11.3. Check Velcro on Dewar Arm

Check the velcro that attaches the cable from the RC cage to the Head Coil Box is securely fastened to the dewar arm. The cable should be housed in the velcro sheath, and the velcro sheath should be attached to the velcro strip on the dewar arm. **It is vitally important you check that this is in place.** If the cable is hanging lose, it may become

taught underneath the dewar arm when you move the dewar RC cage, and tilt the dewar. If this happens whilst there is a participant in the scanner, there is a very real danger that you may cause the participant an neck injury.

4.11.4. Set Up Visual Screen If Approriate

If you are operating a visual study you will need to set up the appropriate screen for the respective study.

1. For seated presentations, you need to hang the material screen up. This screen is attached by two black clips that are on the metal runners, either side of the MEG suite. The only caveat to this is when you are using the eye-tracker, where you'll need to have the mirrored screen. If using the mirrored screen, move this into a convenient position, but do not move it to where the participant will be until the participant is in place.

2. For supine presentations, you need to use the mirrored screen which projects the image above the participant. Move this into a convenient position, but do not move it to where the participant will be until the participant is in place.

4.11.5. Check Auditory Etymotics

Check that the connections on the etymotics are secure, and get some ear tips ready for the participant. The ear tips are in the Auditory drawer of the chest of drawers that back on to the MSR.

5. Pre-Scan: Stimulus Delivery and Response Equipment

The stimulus equipment should be set up prior to the arrival of the participant.

Before You Start

Check the Experiemtal Setup Sheet for the study you are scanning. It may be found in the MEG study setup folder, near megmap. You are advised to do the following checks based on the information in the Experimental Setup sheet, to verify that the stimulus and response setup is correct. You may need to do this with the experimenter (but not the participant) present; in which case, you will need to liaise with the experimenter to organise this. These are things that need to be checked:

- Be aware of what visual and/or auditory stimuli will be used in the study.
- If it is a visual study, is the experimenter using E-Prime / Presentation / Python software? Or another package bespoke to their study? If the stimulus presentation is atypical, familiarize yourself with the required stimulus setup, and consult Appendix E (MEG Wiring Diagram) to set the stimuli up.
- Are responses being collected? If so, what is the response device; Peanut or Lumitouch? And which buttons are to be used?
- If the study uses auditory stimuli, or a default E-Prime / Presentation / Python visual stimulus setup, is the auditory trigger BNC in Channel 1 of the Trigger Inputs section of the DAS? Alternatively, if the study uses a bespoke trigger setup, consult the Experimental Setup sheet, and set up the appropriate triggers.

5.1. Visual Stimulus

5.1.1. Projector

Turn on the power to the projector by pressing the “Power On” touchpad which is located on the upper side of the projector. The power indicator will turn green. When turning on the projector, you also need to turn on the white fan next to the projector; if the fan isn't turned on, the projector is liable to overheat.

N.B. If the power is turned off and then immediately turned on again, it may take a short while before the lamp turns on.

If *ON* is pressed twice, the *POWER* indicator will light up orange and the cooling fan will run for about 90 seconds. The projector will then enter “Standby Mode”.

N.B. The power can be turned on again by pressing the ON button.

5.1.2. Screen

Once the projector is on, you need to check that the image is being projected appropriately onto the screen. Check the three following things:

1. Is the image being projected on the screen?

   If the image is not being projected, refer to the troubleshooting guide.

2. Is the position of the image correct?

   If the image is not being projected, refer to the troubleshooting guide.

3. Does it need to be mirrored / inverted? To mirror or invert, use the remote control change the image. These functions may be found by pressing Menu and then:

a. Scroll up / down to “Main”.

b. Scroll right to “Mirror”.

c. Scroll right to the Mirror Menu.

d. Scroll up / down as appropriate and select “Normal”.

5.2. Auditory Stimulus

5.2.1. Hardware Setup

You need to set up the following auditory stimulus presentation items.

1. Set the required volume on the amplifier (Figure 5.1), as described in the Experimental Setup sheet.
2. Verify that the connections on the Ethymotics tubes in the MSR are secure. If necessary, re-affix and re-tape the section where the two tubes attach.

Figure 5.1. MEG Auditory Amplifier Volume Control

5.2.2. Sound Check

Play the paradigm to check that sound is coming out of the etymotic tubes?

You may need the investigator present to run their stimuli to confirm this.

Alternatively, you can run the “AudTest” script to check for sound. To do this, do the following:

1. Double click on the “AudTest” folder on the Stimulus PC Desktop.
2. Right click on the “TestRun.py” scripy and “Edit with IDLE.”
3. Select “Run Module” from the “Run” drop down menu.

5.3. Stimulus Software / Triggers

5.3.1. Stimulus Software

If you are using an E-Prime / Presentation / Python visual paradigm, check that the image on the appropriate screen in the MSR, is the image that is on the right-hand stimulus monitor in the MEG scan suite.

N.B. If an incorrect image is being shown, refer to the troubleshooting guide.

5.3.2. Trigger check

5.3.2.1. Default Trigger Setup

If the study uses a default auditory or visual paradigm, you will be using the auditory BNC trigger line. To confirm that the triggers are set up correctly, run the Parallel Port Reset program. This will confirm that you are getting

triggers, and also set the trigger-channel in your acquisition to zero. To run the Parallel Port Reset program, do the following:

1. Double click on the “ParallelPortReset” folder on the Desktop of the Stimulus PC.
2. Right click on “reset.py” (with the Python Icon), and chose to “Edit with IDLE”.
3. Select the “Run” option from the “Run” drop down menu.
4. On the Real Time Display monitor you should see the trigger line go high for a few seconds, and then return to zero.

The experimenter may wish to check on the Real Time Display that their stimulus presentation script is sending the appropriate triggers. Should they choose to do this, you will need to re-run the Parallel Port Reset program; as the test run of the stimulus presentation script may have left one of the pins on the parallel port high. So it is essential that the parallel ports are reset after a test run of a stimulus presentation script.

5.3.2.2. Bespoke Trigger Setup

If the study uses a bespoke trigger setup, set up the triggering hardware and cabling as described in the Experimental Setup sheet. Confirm with the experimenter whether there is any reason not to run the Parallel Port Reset script to set all the pins on the parallel port to zero. Unless there is a reason not to run the script; run the script as detailed above. The experimenter may want to run their paradigm to confirm that triggers are present. If they do, you will need to re-run the Parallel Port Reset script (if appropriate).

5.4. Stimulus Response

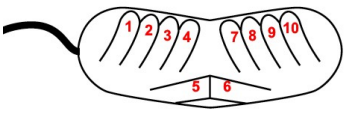
If the study needs a response to the stimulus, switch on the Patient Response Device (in stimulus delivery room).

Figure 5.2. MEG Patient Response Device

The 10 switches correspond to the ten response pads on the Peanut / Lumitouch pads (Figure 5.3). Select the appropriate response button, in accordance with what is specified in the Experimental Setup sheet.

Figure 5.3. Lumitouch / Response Device Mapping

Figure 5.4. Peanut / Response Device Mapping



6. Pre-Scan: MEG Software Acquisition Setup

Before You Start

This section shows you how to setup a new scan. If the study already has a previously defined scan template, you can skip this section and go to Chapter 7 (Experimental Procedure). Further information to complement this chapter may be found in the 4D Software Manual, Chapter SI..

6.1. Logon and Startup

1. Log on to Megmap (if necessary)
2. Switch on Sun computer and log on:
3. Username: xxx
4. Password: xxxxxxx
5. Start up the Magnetic Source Imaging (MSI) Software: Right mouse click on the desktop and select “Magnetic Source Imaging” from the drop-down menu. The window in Figure 6.1 will appear

Figure 6.1. Patient Selection Window

6.2. Setting up a New Scan

Additional information on use of the MSI software is available in Section AS-2 of the MSI reference manual.

Figure 6.2. Data Acquisition Window

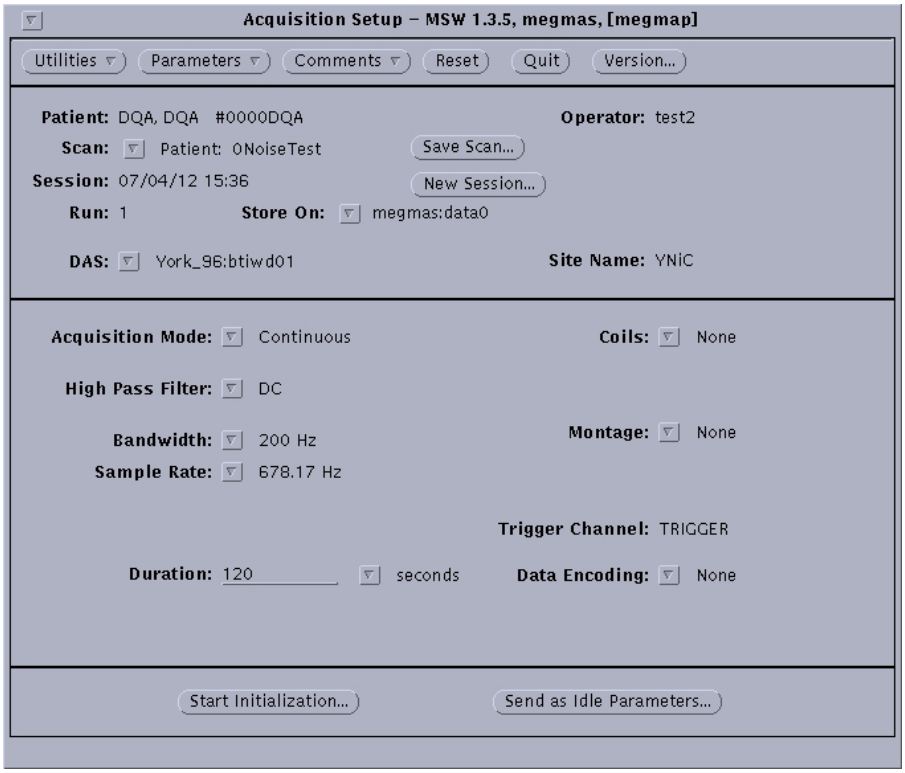


Figure 6.3. Real Time Display Control

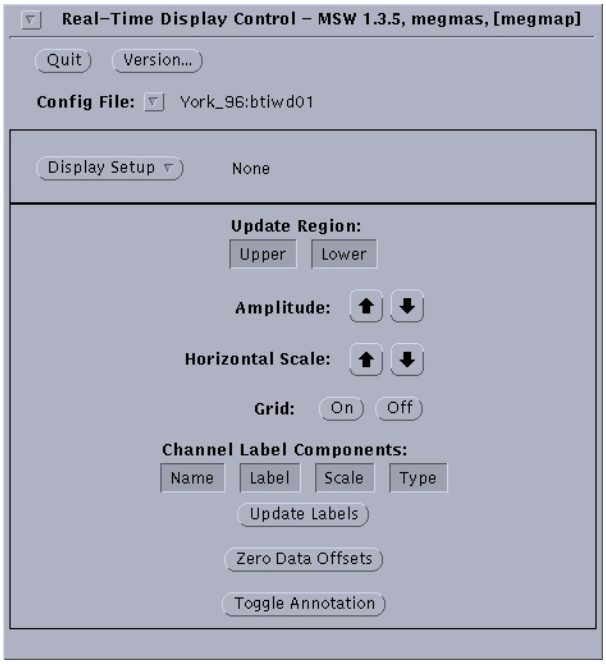
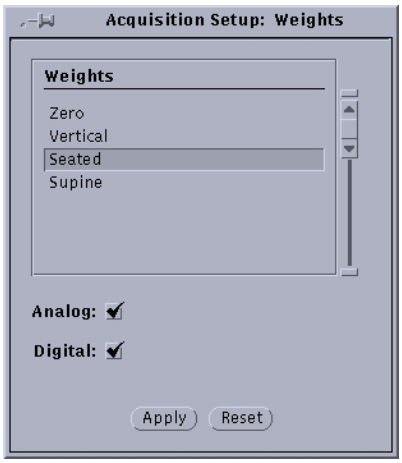


Figure 6.4. Acquisition Weights Control



1. On the “Patient Window”. Click on “Acquisition Setup”. The following window shown in Figure 6.2 will appear.

2. Click on “Acquisition Mode” and select the appropriate option:

   a. “External” is used when the trigger is produced from an external program, e.g. Cambridge Research Systems.

   b. “Internal” is used when Megmap itself generates the trigger.

   c. “Continuous” is used when you want to record all data from a specified time interval (N.B. if this option is selected no epoch specification is required, ignore stages 4 and 5 and instead specify “Duration” of the experiment in seconds allowing extra time for unforeseen delays during the experimental procedure).

3. Click on “Data Type” and specify which form of data you wish to collect:

   a. “Raw” collects only raw data. It is advised to select “Raw” because you can average the data at a later point.

   b. “Raw and Average” collects raw data as well as calculating an online average.

   c. “Average” calculates only an average of the data and does not store raw data (N.B. this option is rarely required).

4. Enter values for “Epoch Duration”, “Pretrigger Duration” and “Number of Epochs” as determined by your experimental design. (N.B. Epoch Duration should be calculated to include the Pretrigger Duration).

5. Click on “High Pass Filter” and select the appropriate value from the drop-down menu. The default and recommended filter is DC, as this preserves all the data. Some experiments may wish to acquire data with a 1 Hz filter, if they have a good reason to. However, we **do not** recommend recording with a 0.1 Hz filter.

6. Click on “Bandwidth” and select appropriate value (usually 200 Hz) from the drop-down menu. The bandwidth is set at 200 Hz because users are not usually interested in acquiring data at frequencies higher than 200 Hz.

7. Check that “Sample Rate” is set to 678.17Hz. The default sample rate is set at 678.17Hz because most users are interested in responses below 40 Hz. Additionally, using a higher sample rate requires a larger amount of disc storage.

8. Click on “Coils” and select “5 coils” from the drop-down menu.

9. Click on “Coil Acquisition Prompt” and select appropriate option from the drop-down menu:

a. “Prompt” provides a prompt warning window before head coil positions are acquired before and after the experiment.

b. “Don't Prompt” does not provide a prompt window before acquiring head coil positions before and after the experiment.

10. Click on “Transform Calculation” and select “Coil Matching” from the drop-down menu.

11. Click on “Montage” and select “5 Coils” from the drop down menu.

12. Do not change settings for “Trigger Channel” or “Data Encoding”.

13. Click on “Parameters” and select “Real Time Display” from the drop down menu. The window shown in Figure 6.3 will appear.

14. Select a display option from the “Choose existing setup” list displayed by right mouse click (N. B. usually “SenYNiC” template is used). Click “Apply”.

15. Click on “Parameters” and select “Weights” from the drop down menu. Select the option appropriate to your experimental design (usually “seated” or “supine”) and click “Apply”.

16. In order to make a template of the settings just specified, and to save time on future occasions click “Save Scan” and name the template. Subsequently this template can be selected from the top window of “Acquisition Setup” by right mouse click on “Scan” and selecting it from t the drop down menu. Your settings will then appear in the lower window.

To check these parameters are selected correctly and rule out the presence of any artefacts click “Send As Idle Parameters”. Once the parameters are configured, the selected scanner read out will be displayed on the display monitor.

7. Scanning: Experimental Procedures

Before You Start

Know the study requirements in the Experimental Setup sheet. Experimental Setup sheets for each study can be found in the MEG study setup folder, near megmap. Once you are familiar with the study, ensure the following is done before starting:

- Log into megmap.

  If you have problems doing this, see Chapter 6 (Software Acquisition Setup).

- Set up the MSR accordingly; is the chair / bed prepared accordingly? Is there blue hygienic couch paper on the bed / chair and cushions?

  If there are any problems here, see Chapter 4 (MSR - Magnetically Shielded Room).

- Set up the stimulus hardware.

  If you have problems doing this, see Chapter 5 (Stimulus Delivery and Equipment Setup).

- Check the stimulus software; can you see triggers on the Real Time Display?

  If you have problems doing this, see Chapter 4 (MSR - Magnetically Shielded Room).

- Check that the camera and intercom working properly?

  If you have problems doing this, see Chapter 4 (MSR - Magnetically Shielded Room).

- Check that the O_2 level is appropriate?

  If you have problems doing this, see Chapter 3 (Entry into MEG).

7.1. Participant Preparation

7.1.1. Briefing the participant

Firstly, verify that the participant has completed and understood the Full YNiC Consent forms.

Remember, you as the Operator have ultimate responsibility for ensuring that everything on the Full Consent form has been completed and is correct.

1. Ensure the participant is aware of the closest fire exit from the MEG room.
2. Make sure that the participant has removed all metallic items from their person. These include less obvious items e.g. belts, underwear, makeup and hair bands.
3. Explain how to open the MEG room door from the inside. Be sure to cover both standard and emergency procedures. (see Chapter 4 MSR - Magnetically Shielded Room).
4. Verify that the participant has not had an MRI within 3-4 days before the MEG scan, as there is a possibility of residual magnetization. This generates noise on the MEG scan. If they have had an MRI within 3-4 days, it is up to the Principle Investigator (PI) for the study whether you should procede or not. You as the operator are only responsible for identifying whether there has been a recent MRI, and informing the PI of this information.

7.1.2. Hygiene

Please remember to keep MEG as clean and tidy as possible and that a standard level of cleanliness must be maintained. Patients and participants should feel that they are entering a professional, clinical environment when they enter MEG.

7.1.2.1. Hand Cleaning

Antiseptic hand cleansing gel must be used before and after handling a participant.

7.1.2.2. Antiseptic Skin Wipes

Participants must wipe their foreheads and ears with the alcohol-free wipes before the coils are attached. Explain to the participant that the wipes will remove moisturiser, makeup and natural oils from the skin to aid coil attachment.

7.2. MEG Software Setup

7.2.1. Store Participant Information

The Patient selection window is shown in Figure 7.2. In this window, the following procedure must be performed:

1. Ensure that no participant is currently selected using right mouse click in the list of participants and choosing “Deselect All Patients” from the drop-down menu.

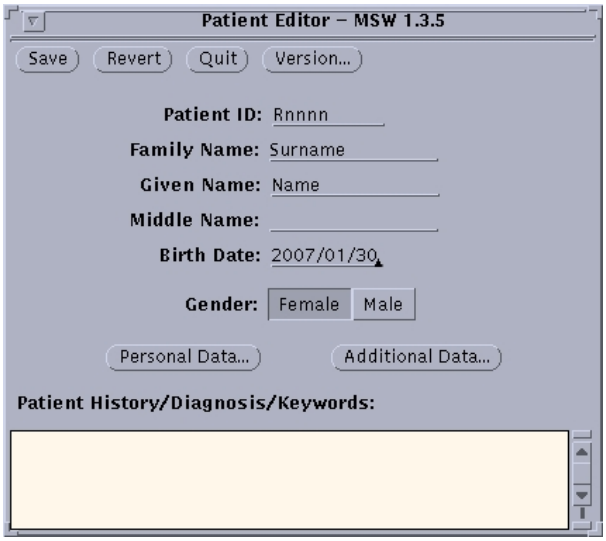
2. Click on “New Patient”.

3. In the dialog shown in Figure 7.1 Enter participant ID (beginning “Rnnnn”) and scan name (“Pnnnn”), if the scan has already been set up.

4. Enter participant's personal details; name and date of birth (in the format yyyy/mm/dd).

5. Click on “Save”.

Figure 7.1. Patient Editor Window



7.2.2. Choosing a Specific Participant

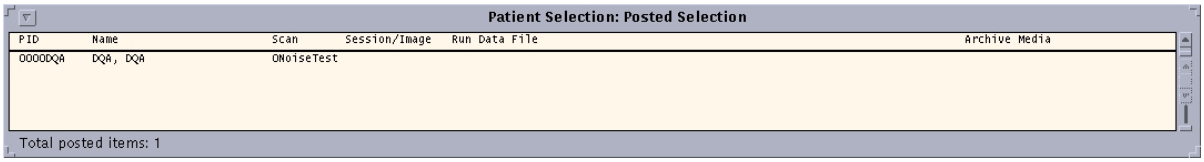
1. Once a new patient has been added, they will appear in the list on the left side of the window.

2. Choose the correct participant by clicking on the corresponding box on the left-hand side of the name. A tick will appear in the box.

3. Click on “Post Selection.”

4. To ensure your participant is selected click on “Show Posted Selection”. The participant name should appear in a new window at the bottom of the screen.

Figure 7.2. Patient Selection Window



7.2.3. Select the Scan

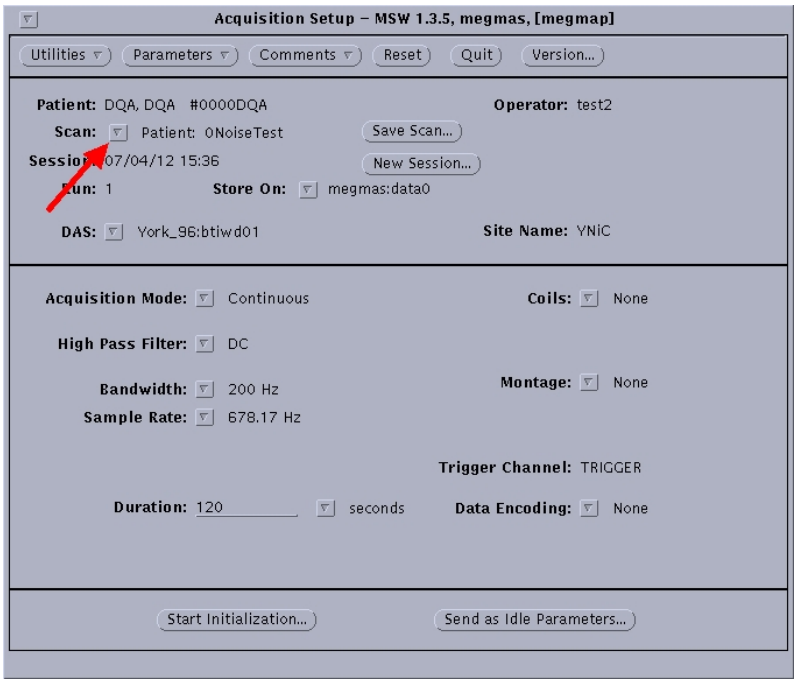
1. Click on “Acquisition Setup”.

2. Load a previously specified template: Click on “Scan” and select the scan template form the drop down menu.

3. Check that the selected scan is the appropriate one.

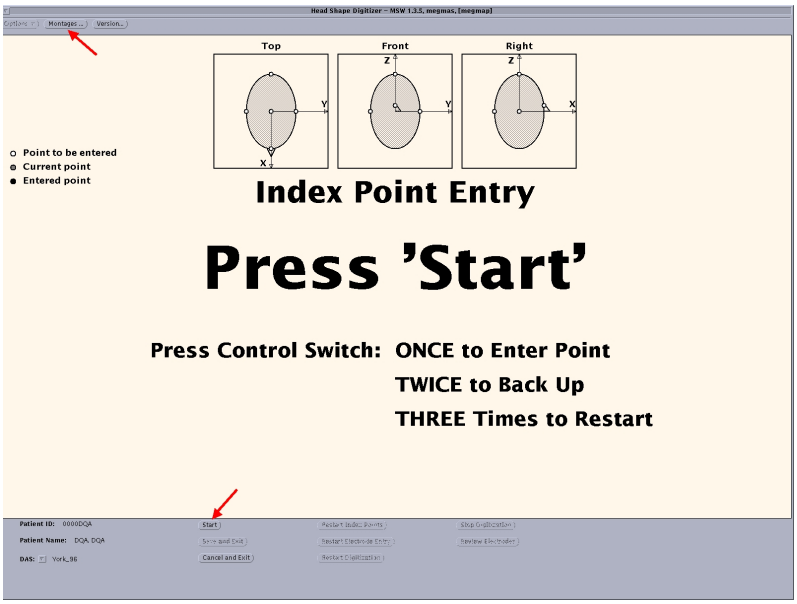
4. Rule out the presence of any artefacts: Click “Send As Idle Parameters” and the selected scanner read out will be displayed on the display monitor.

Figure 7.3. Acquisition Setup - Choosing a Scan



7.3. Head Coil Acquisition and Digitisation

Figure 7.4. Head Shape Digitisation



1. In the “Patient Selection” window, click on “Digitise Head Shape”. Click on “Montages” and select “EEG 5 Coils” (double-click pin in top corner to close).

2. Click on “Start”.

The fiducial points or head coil placements are used for head localization (the process of locating the participant's head in co-ordinates which are relative to the magnetometers). They are later used to co-register the MRI Coordinate System with the MEG Head Coordinate System.

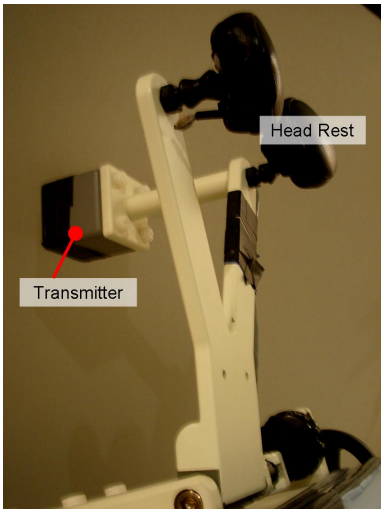
You are now ready to put the participant in the MSR.

7.4. Enter the MSR and Attach the Head Coils

1. Enter the MSR.

2. Attach the Polhemus head rest to the back of the chair, see Figure 7.5.

Figure 7.5. Polhemus Head Rest



3. Ask the participant to sit in the chair / lay on the bed. Adjust the chair to make the participant as comfortable as possible e.g. raise the back of the bed to give the participant's neck more support.

4. Clean the participant's forehead and area in front of the ears using an alcohol-free wipe.

The fiducial points or head coil placements are used for head localization (the process of locating the participant's head in space relative to the magnetometers). They are later used to co-register the MRI Coordinate System with the MEG Head Coordinate System.

Figure 7.6. Coil Attachment: Anterior View

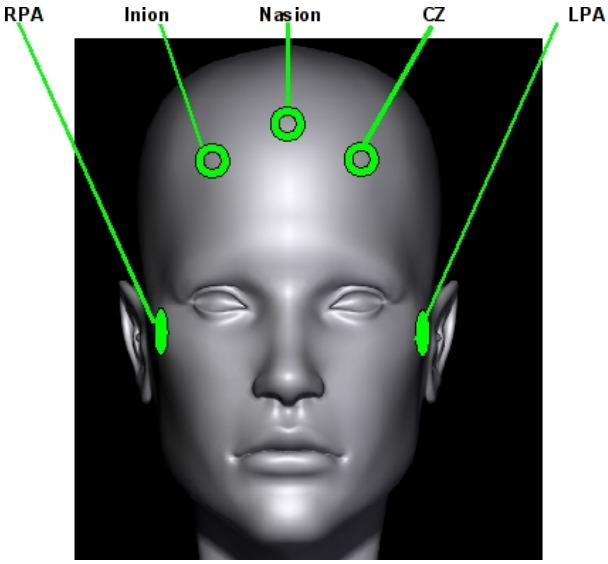
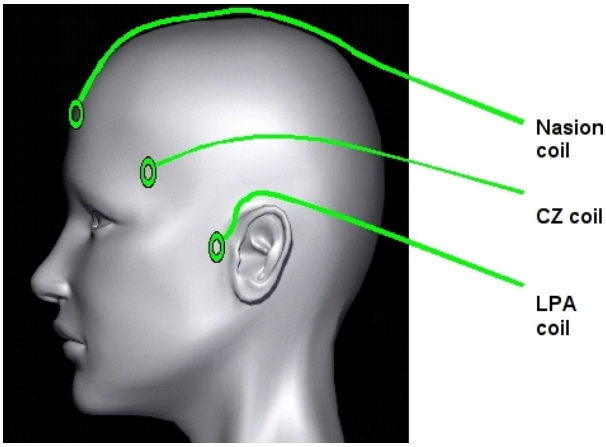


Figure 7.7. Coil Attachment: Side View



1. Ensure each coil's label and colour corresponds to the correct port on the coil panel.

2. Cut 5 short strips of tape (approximate length 4 cm each). Use these strips to attach the labelled coils to the correct positions on the participant's head (see Figure 7.6 and Figure 7.7 for help). The leads from the coils should be draped towards the back of the participant's head (see Figure 7.7).

3. Place Head Coil 1 (LPA) at the left and Head Coil 2 (RPA) at the right preauricular points (indentation just above the tragus), or on a section of hard cheekbone nearby on each respective side of the head.

4. Place Head Coil 3 (Nasion) above (3-4 centimetres) the nasion (indentation between the forehead and the nose) midline.

5. Place Head Coil 4 (Cz) 3-4 centimetres on the left of Coil 3.

6. Place Head Coil 5 (Inion) 3-4 centimetres on the right of Coil 3.

7. Use a small section of tape, with a cross on it, to draw a reference point on the bridge of the nose.

N.B. The coil placements in steps 4, 5 and 6 ***should not*** *be in a straight-line. Depending on the participant's respective hairline and scalp topology, coils 3, 4 and 5 should be in the shape of either a triangle, or an inverted triangle.*

7.5. Head Digitisation

7.5.1. Acquire Coil Positions

1. Ask the participant to rest their head on the Polhemus and to keep their head as still as possible. During digitisation they will also need to keep quiet and keep their head resting on the head rest until you tell them that the process is complete.

2. Use the Polhemus stylus to digitise the participant's head shape, see Figure 7.5. Place the point in the centre of a coil and press the Polhemus button to record the location; a 'beep' informs you the location was recorded, see Figure 7.9. The order of entry is as follows:

   a. Left PA.

   b. Right PA.

   c. Nasion.

      N.B. Note that this reading is not taken from the coil but from the bridge of the nose.

   d. CZ (left-hand side of the head).

   e. Inion (right-hand of the head).

Figure 7.8. Polhemus Stylus

Figure 7.9. Polhemus Button

3. Press the button once to accept. Your will hear two BEEP-sounds.

4. The above procedure is then repeated.

5. Press the button once to accept and verify discrepancy. A maximum discrepancy of less than 0.2 cm is ideal. If the discrepancy is greater than 0.3 cm, it is recommended that the procedure be redone. The software will explain how to restart.

6. Press the button once to enter digitize mode. You will hear one BEEP-sound.

7.5.2. Head Shape

At this point the computer will inform you that the Polhemus stylus is in “off” mode.

1. Ask the participant to close their eyes.
2. Place the tip of the stylus on the participant’s head and press the Polhemus push button to go into “on” mode.
3. Draw out the participant’s head shape: First trace an outline of the participant’s eyes and nose. Next draw a series of undulating lines across the forehead, scalp and back of the participant’s head to ensure a good head coverage.
4. Whilst in “on” mode ensure that the stylus is constantly in contact the participant’s head. If you need bring the stylus away from the patient’s head during the drawing process, go into “off” mode by pressing the Polhemus button.
5. When you are satisfied with the head shape press twice to accept. You will hear a BEEP-sound.

7.5.3. Acquire Coil Positions (second time)

The coil positions are now entered. The megmap computer will “beep” when the reading has been taken.

1. Coil 1 – LPA.
2. Coil 2 – RPA.
3. Coil 3 – Nasion N.B. the reading is now taken from the actual coil.
4. Coil 4 – Cz (left-hand side of the forehead).
5. Coil 5 – Inion (right-hand side of forehead).
6. Click once to accept.
7. The digitisation window will close.
8. Remove the Polhemus head rest.

You are now ready to start the experiment

7.6. Positioning Participant in the Dewar

7.6.1. Seated Procedure

1. The dewar should be tilted at the mark for seated recording.
2. If it is an auditory experiment, ask the particpant to insert the eartips before raising the chair.
3. Bring the dewar forward until it is directly above and centred over the participant’s head. Ask the participant to rest the back of their head inside the helmet and reposition until it is comfortable for the participant to lean their head in the scanner.
4. Push the cage back as far as possible before the participant’s head is raised inside the helmet. Then, slowly raise the chair until the participant can feel the top of the helmet lightly touching the crown of their head. (see Section 4.5, in Chapter 4 MSR - Magnetically Shielded Room). Ask the participant to breathe deeply and “slouch” down in the chair to simulate relaxation during the course of the experiment.
5. Once the participant has relaxed, slowly raise the chair again until the participant can feel that the top of their head is near to/touching the top of the helmet helmet. If it is a visual experiment, the participant's head should be as close to the top of the sensor helmet as possible without blocking their view of the screen.

Caution

Care should be taken when adjusting the chair height while a participant is seated under the helmet. Always adjust the chair very slowly in small increments when their head is well inside the helmet.

6. Move the projector screen to the appropriate distance from the participant's face. Check that the participant can see the stimuli properly on the screen.

7. Give the response device to the participant and show them how to hold it comfortably (a cushion may be placed on the lap).

7.6.2. Supine Procedure

1. Remove the Polhemus head rest.

2. Ask the participant to sit up.

3. If it is an auditory experiment, ask them to put the ear tips connected to the Etymotic tubes. Participants should compress the ear tips with their fingers until the sponge becomes slim enough to be inserted into the ear canal. Once the ear tip is inside the ear canal, the participant should hold it in place for a few seconds until the sponge has expanded sufficiently to provide a snug fit.

4. Whilst the participant is inserting the ear tips, tilt the dewar to the mark on the dewar arm designated for the supine procedure.

5. Move the RC cage as far back as possible.

6. When the dewar is tilted at the correct angle, bring it forward until it is almost touching the top of the bed.

7. Raise/lower the bed to roughly the same height as the dewar helmet.

8. Place a foam pad inside the dewar helmet where the participant's head will rest.

9. Ask the participant to move their head into the helmet. This will require guidance.

10. Place the etymotic tubes so that they are lying on the participant's body and over the foot of the bed. Ensure that the weight of the tubes is not pulling them across the body or over the side of the bed. Allow the participant plenty of slack in the length of the etymotic tubes whilst they try to get themselves into position.

11. Instruct the participant to move down the bed so that they have enough room to lie down but not hit their head on the helmet. Then he/she should wriggle back up the bed and get their head as far as possible inside the helmet. This procedure can be difficult so give the participant as much help as possible. Hold the dewar steady with the handles until the participant is in the correct position.

12. Make sure that the ear tips do not come out of the participant's ears. You may want to use tape to hold the ear tips in place.

13. If the supine screen is required, place it in position, verifying that the stimuli are visible to the participant.

7.6.3. Special considerations for patients

Some patients will require special attention. Under these circumstances the experimenter who booked the MEG session is ultimately responsible for the welfare of the patient. The experimenter should remain in MEG for the duration of the experiment.

In case of an emergency, the operator should explain to the patient how to get out of the helmet and get off the bed without assistance. To evacuate patients quickly, sheets can be placed under the patient.

7.7. Leaving the MSR

1. Place foam pads to give the participant extra head support and thus reduce head movement.

2. Inform the experimenter that now is the last opportunity for the participant to be briefed about the experimental task.

3. Allow whatever time the particiapnt needs to ask questions to the experimenter about doing the task.

4. Leave the MSR and adjust room lighting.

5. Verify that the participant and you can hear each other via the Intercom, and see them on the IR camera.

You can now begin to acquire the MEG data. Follows instructions in Chapter 8 (Scanning: Recording Data)

7.8. The Participant Does Not Turn Up on Time

Inevitably, there will be occassions when a participant does not turn up for a scan. If you are the operator for the scan session, you are required to remain in MEG for the duration of the scan. There is an iMAC workstation upon which you can work; this is an image of the workstations in Open Plan. If, for whatever reason, you have to leave the Scan Suite, you must inform Reception of your whereabouts. The only exceptions to this are:

1. You are operating for your own study, and you decide to abort the scan session.

2. The experimenter decides that there will not be enough time for the scan, and so the experimenter aborts the scan session.

Should a participant turn up late, you need to make a decission as to whether the scan will be able to be completed in the amount of time that is left in the booking.

If, in your view, the study will overrun, you should inform investigators that should their study overrun, then the investigator will be penalized. The amount of time that the investigator overruns by will be rounded up to the nearest 15 minutes, doubled, and then subtracted from their REC alloted MEG time allowance. And if there is a subsequent study that has been inconvenienced, an equivalent amount will additionally be taken from the overrunning groups REC alloted MEG time, and added to the subsequent studies REC alloted MEG time allowance. Thus effectively fining the transgressing study quadruply for their overrun.

8. Scanning: Recording Data

8.1. Checking for Artefacts

After you have confirmed intercom contact with the particiant, you need to check that there are no metallic artefacts that will contaminate the recording.

- If you have a typical Scan Setup, with the “SenYNiC” Display Setup, and filtering is set up as “DC Coupled”, the Scan Setup should be “Sent as Idle Parameters”.
- If only have a different Display Setup, you can “Send as Idle Parameters”, and simply change the Display Setup to “SenYNiC” from the Parameters drop down menu. Otherwise, you will need to load up the DQA setup, and “Send as Idle Parameters”.

When you have the channels scrolling idly on the “Real Time Display”, you need to do the following:

1. Look for abnormal activity on the channels. They should be stable.

   If the channels have large perturbations, there is some metallic contaminant that will need to be removed before acquisition. This may involve the participant leaving the Scan Suite to get changed. Check with the participant if they have anything metallic on them. Typical metallic items include hair bands, metallic make-up, necklaces, belts, bras and metallic studs on trousers.

2. Once the channels are flat, continue with the following 3 checks.

3. Ask the participant to blink 3 times; you should see 3 small shifts on the traces related to the blinks.

   If the channels have large perturbations, it is likely that the participant is wearing make-up with metallic components. This will need to be removed before acquisition. (This may involve the participant having to leave the Scan Suite.)

4. Ask the participant to look left, look right, and then look around the room - whilst keeping their head still. You should see muscle artefacts similar to those seen with the blinks.

   If the channels have large perturbations, it is likely that the participant is wearing make-up with metallic components. This will need to be removed before acquisition. (This may involve the participant having to leave the Scan Suite.)

5. Ask the participant to take 2 deep breaths that are held for 5s before releasing. There should be little or no shift on the channels.

   If the channels have large perturbations, it is likely that the participant is wearing something metallic. Typical metallic items are belts, bras, necklaces and metallic studs on trousers. These will need to be removed before acquisition. (This may involve the participant leaving the Scan Suite to get changed). N.B. If the participant is not already in scrubs, they should get changed into scrubs.

Once you have completed the artefact check, and you are confident that the participant does not have any metallic artefacts, you will be ready to Acquire. If you have done the artefact check using the DQA scan setup, you will need to re-load your scan, (see Chapter 7 Experimental Procedures).

8.2. Data Acquisition

8.2.1. Starting Data Acquisition: Including Acquiring Head Coils.

Before starting the recording, talk to the participant through the Intercom, and establish IR Camera contact. Explain to the participant how long each condition will run for. Verify that the participant is comfortable and ready to begin recording. Ask the participant to keep as still as possible and to remain still until they hear the operator’s voice again at the end of each run.

1. To start recording, click on “Start Initialization” on the “Acquisition Setup” window.
2. When prompted, ask the participant to keep as still as possible and to remain still until they hear the operator’s voice again at the end of each run.
3. Then click on “Acquire” head coil positions in the dialog shown in Figure 8.1.
   a. You should see the Coil Acquisition screen on the Real Time display
   b. The Coil Calculation window with the coil errors will appear on the megmap screen. If the error is under the thresholds level, continue.
4. Select “Acquire Data” and wait until you see the signal from the MEG channels on the real time display.
5. Inform the experimenter to start stimulus delivery.

Figure 8.1. Acquire Head Coil Positions

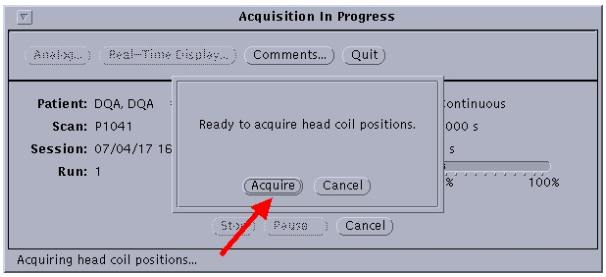
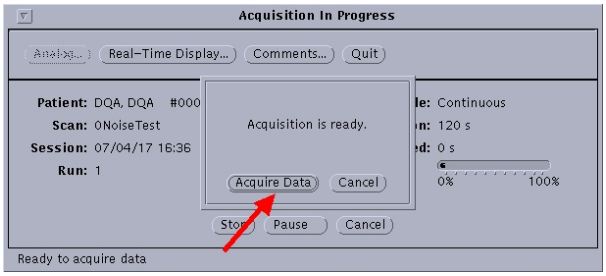


Figure 8.2. Starting Data Acquisition

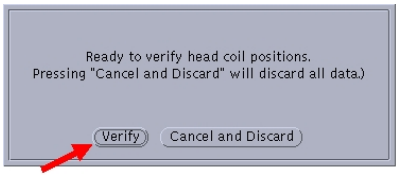


8.2.2. Finishing Data Acquisition

If the scan has been set up in epoch mode, recording will stop automatically.

If the scan has been set up in continuous mode, you will need to do the following to finish the scan:

Figure 8.3. Finishing Data Acquisition



1. When the experimenter informs you that their stimulus presentation has finished, click on “Stop” in the “Acquisition in Progress” window.

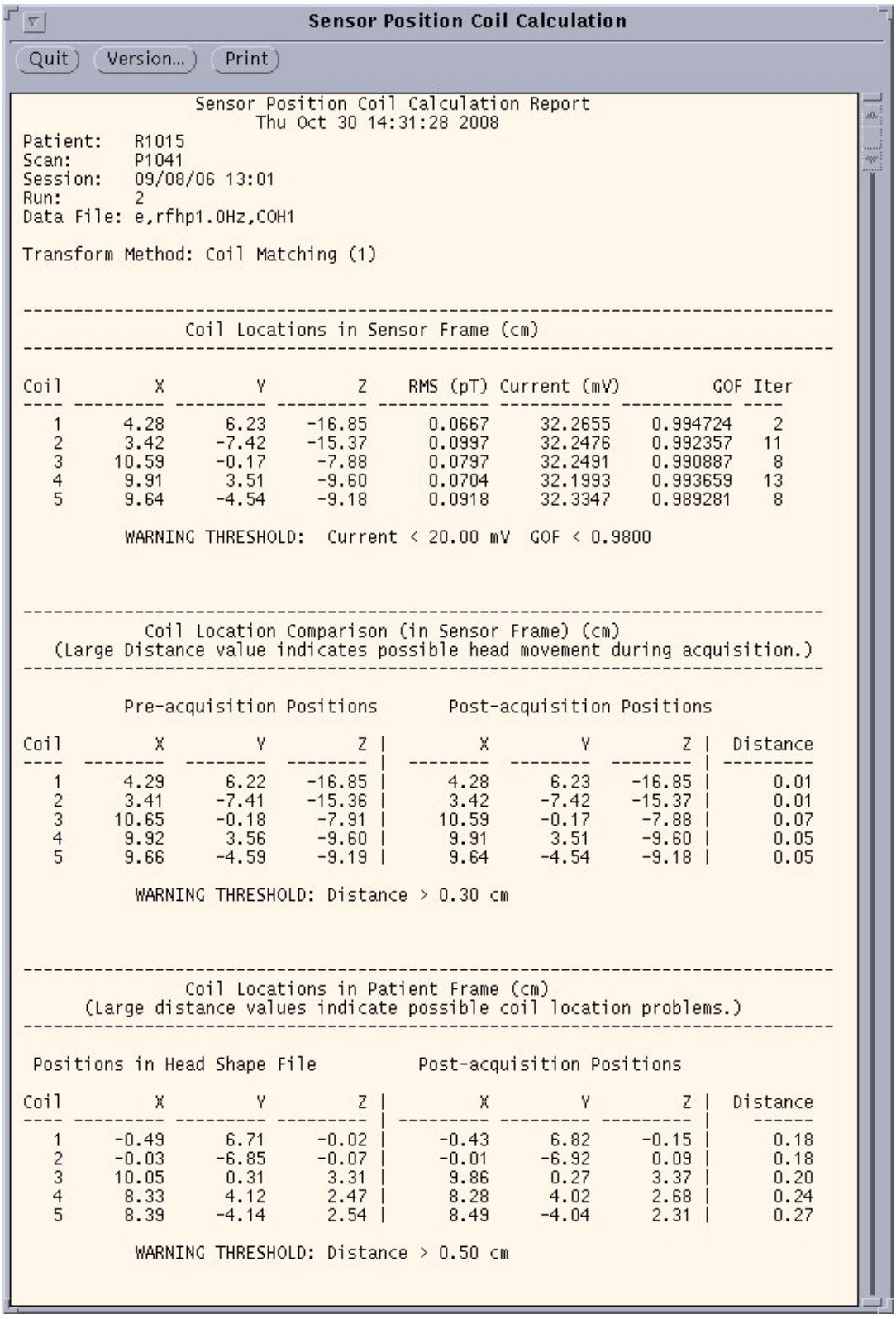
Caution

Do not click on Cancel at this point. Cancel should only be used when you want to discard the data.

2. When prompted, Click on “Verify” head coil positions. The maximum discrepancy between the initial values obtained with the localised coils and head shape should be less than 0.8 cm (LPA and RPA tend to move the most between digitisation and recording).

3. The last coil Calculation will appear on screen. You can verify how much movement there is by checking the error shown in the Sensor frame calculations, as shown in Figure 8.4.

Figure 8.4. Final Coil Calculation



9. Scanning: Data Handling

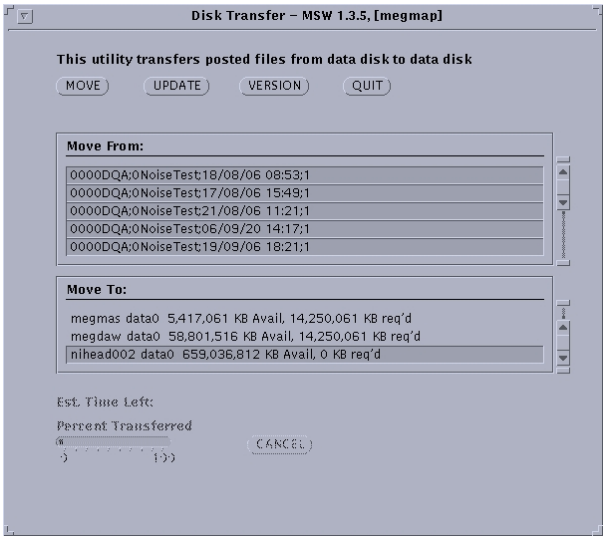
9.1. Uploading Data

Data must be uploaded to the main storage server at the end of each MEG session.

1. Select patients.
2. Post the data set to be transfered.
3. Click on “Disk/tape” and select “Disk Transfer”.
4. On the Disk Transfer window select “nihead002” and click “Move”.
5. The window will not close on its own after the transfer is done. You will need to click on “Quit”.

If you are having trouble transfering data, refer to the troubleshooting guide.

Figure 9.1. Data Transfer



9.2. Creating m4d Files: (Done Outside the Scan Suite)

When you have transferred the data, you need to create the m4d files for the recording. This is done on the megdaw machine, which is in the Stimulus Preparation Room. The m4d files are files created to allow the data to be read using MATLAB and other analysis software.

1. Log on to megdaw (Note: not megmap in the MEG Suite).
2. Open a shell (Right click on the screen, right click on “Programs” in the pop-up menu, and right click on “Command Tool”.
3. Type the following at the command prompt:

```
bash
```

4. Press “Enter”, this should change the test at the start for the command prompt. Then type:

```
create_all_m4d.sh
```

5. The m4d files should take 10-15 minutes to generate.

10. Scanning: Leaving MEG

Leave the MEG lab clean and tidy after every session and ready for use by the next operator. This includes returning the lab back to its default state.

10.1. Participant Clean Up

1. Remove the head localization coils from the participant's head by pulling on the tape and not the coil wires.
2. If applicable, remove the EOG / EMG electrodes.
3. Clean the skin with an alcohol-free wipe; rub gently.

10.2. Equipment Clean Up

The MEG suite must be kept as clean and tidy as possible and a standard level of cleanliness must be maintained. Patients and participants should feel that they are entering a professional, clinical environment when they enter MEG.

1. Remove the tape from the electrodes and clean with alcohol-free wipes. Hang the head localization coils on the side of the dewar.
2. Use the disinfectant alcohol-free wipes to clean every surface that comes into contact with participants including inside the dewar helmet, the support pads, response pads, Polhemus head rest, and the digitisation stylus.
3. If applicable, clean the EOG / EEG electrodes with distilled water and a mild detergent. Gently rub the electrodes using a toothbrush to dislodge electrolyte residue. Pat dry and leave to air dry.
4. Put back all cables tidily in the correct place. All cables MUST be untangled and put back on the correct hooks. The hooks inside the MSR are labelled. Ensure there are no cables lying on the floor. A common problem is incorrect storage of the Polhemus head rest. The head rest should be stored as shown in the Figure 10.1.
5. Remove any used tape left on the coils or anywhere else (including the floor).

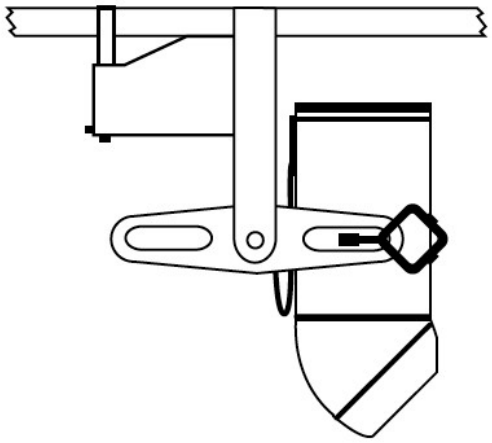
Figure 10.1. Polhemus Cable Storage

10.3. Return MEG to its Default Setup

At the end of the scan, you need to return the MEG suite back to its default state. To do this, you must do the following:

1. Un-post all participants from the Patient Selection window.
2. Return the MEG dewar to the upright position. See Figure 10.2

Figure 10.2. MEG Dewar in Vertical Position



3. Return the MEG chair / bed to the the seated position, and lower it to floor-level.
4. Put all equipment and cables in the MSR back tidily in the correct place.
    a. The Polhemus equipment belongs on the back wall. The location for each cable is clearly labelled (Figure 10.1).
    b. The auditory cables should be loosly wound, and hung on the hooks between the projector waveguide and the MSR door.
    c. The visual screen should be un-clipped and left against the wall that divides the MSR and the MEG Scan Suite.
    d. The mirrored screen should be left by the MSR shelves that house the blankets and cushions.
5. Turn the MSR light off.
6. Close the MSR door, and check that it is properly closed.
7. In the MEG backroom:
    a. Turn the projector to standby mode
    b. Make sure that all the ten switches on the Response Device are turned to ON.
    c. Ensure on the Interface Box that; the Lumitouch is selected, the CRS is OFF, and both the Left and Right PCs are Enabled.
    d. Turn off the IR Camera.
    e. Ensure that the “auditory trigger” BNC is plugged into “Trigger input 1” on the User Interface panel of the DAS.
    f. Ensure that the “proj rack 1” BNC is plugged into “X1” on the User Interface Panel of the DAS.

    Additionally, if you have operated for a study with a bespoke trigger / stimulus presentation setup, return the backroom to how you found it.

g. Detach any extra BNC cables you may have used from the User Interface Panel on the DAS.

h. If you have modified any of the wiring to the stimulus presentation hardware, return it to the state you found it in.

8. In the MEG Scan Suite:

   a. Turn off the screen on the Stimulus Delivery PC monitor.

   b. Turn off the screen on the EEG PC monitor.

   c. Turn off the screen on the Real time display monitor.

   d. Turn off the IR Camera monitor.

9. If you are the operator for the last session of the day:

   a. Log off from the MEG system and turn off the monitor. This is done by quiting the Magnetic Source Imaging software, then right clicking on the desktop, and selecting “Exit”.

   b. Spray inside MSR with disinfectant to freshen room.

The MEG manager, or a designated proxy, will check the state of MEG at the end of each day. If you do not return the lab to its default state, you will be contacted by the MEG Manager.

Appendix A. Daily Quality Assurance Checks

These checks must be performed by the first operator to use the room every day. It is the operators responsibility to ensure that if they are the first person to scan in a day, that they arrive in time to perform these checks before scanning.

A.1. Oxygen Level Checks

The Oxygen level of the scanner must be checked daily. The Oxygen monitor is in the MEG Backroom, see Figure 3.2. The value on the monitor should be recorded in the log book.

1. A normal value for the O_2 level is between 20% and 21%.
2. If the level is below 20%, this needs to be reported.

   Contact reception, who will contact a member of staff. A staff member will then investigate the problem.

Warning

If the O_2 level falls below 19%, no-one should enter the MSR without being authorised to do so by a member of staff; as the O_2 level unstable. There is a danger that the O_2 may drop to below the 18% level, when the alarm sounds, and the MSR has to be evacuated.

A.2. Helium Level Checks

The Helium level of the scanner must be checked daily. In the event that the Helium level falls beneath 20%, contect reception, and ask them to alert a member of YNiC staff that the Helium level is low.

Figure A.1. Helium Monitoring

1. Make sure that the dewar is in the upright position.
2. Turn on and log in to the Sun computer megmap.
3. Right click on the desktop.
4. Click on “Magnetic Source Imaging”.
5. In the “Patient Selection” window, click on “Utilities” and then “Display He Information”.
6. Select “Update Level”.
7. If the reported level is below 20%, contect reception, and ask them to alert a member of YNiC staff that the Helium level is low.

A.3. Check Data Quality

1. Put the dewar in seated position and push the RC cage back.

2. Switch off lights, projector and camera.
3. Shut both doors in the stimulus delivery room.
4. On megmap post subject selection: 0DQA and scan: 0NoiseTest
5. Click on “Send Idle Parameters”
6. Click on “Acquisition setup”
7. Click “Start Initialisation” and then “Acquire data”.
8. Check screen for relatively flat channel readings during the 2 minute data acquisition.
9. It is OK if the reference channels (channel names contain the letters “M” and “G” are not as flat as the other channels.
10. If channels are drifting, choose “zero data offset” (on Real Time Dispaly menu) to rescale y-axis on DAS.
11. Post the recorded DQA data and load it into a Data Editor window. Check all channels throughout the duration of the DQA recording for unusual activity. Then filter the data using the DQA bandpass filter.
12. Post the filtered data and re-load into the Data Editor window. Again, check all channels for artefacts and anomalies.
13. Report any artefacts or other comments on the data in the log book.
14. Remember to return the dewar to a vertical position when you have finished.
15. Upload data to storage server: “nihead002”

A.4. Check Overall Cleanliness of MEG

- Examine both the control room and the scanner room to ensure that they are clean.

Appendix B. Operating the Eyetracking System: (ASL Eyetrack 6000 with Long Range Optics)

B.1. Operating Principles in Eyetracking

Eye tracking is the process of measuring either the point of gaze ("where we are looking") or the motion of an eye relative to the head. An eye tracker is a device for measuring eye positions and eye movements. Eye trackers are used in research on the visual system, in psychology, in cognitive linguistics and in product design. There are a number of methods for measuring eye movements. The most popular variant uses video images from which the eye position is extracted.

The most widely used current designs are video-based eye trackers. A camera focuses on one or both eyes and records their movement as the viewer looks at some kind of stimulus. Most modern eye-trackers use contrast to locate the center of the pupil and use infrared and near-infrared non-collimated light to create a corneal reflection (CR). The vector between these two features can be used to compute gaze intersection with a surface after a simple calibration for an individual.

Two general types of eye tracking techniques are used: Bright Pupil and Dark Pupil. Bright Pupil tracking creates greater iris/pupil contrast allowing for more robust eye tracking with all iris pigmentation and greatly reduces interference caused by eyelashes and other obscuring features. It also allows for tracking in lighting conditions ranging from total darkness to very bright. The ASL 6000 eyetracker used at YNiC is a bright-pupil eye tracker.

Figure B.1. A Pupil Being Tracked.

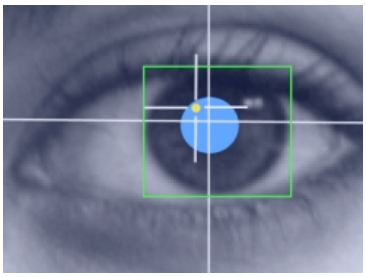
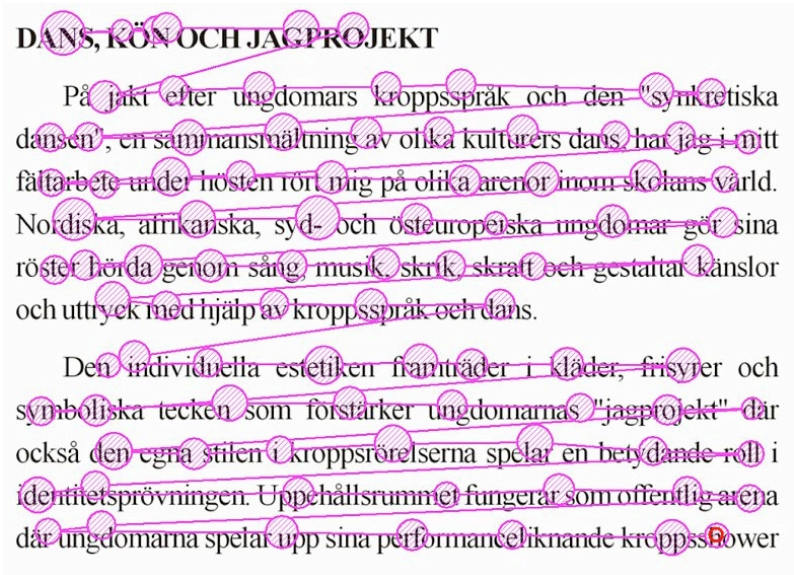


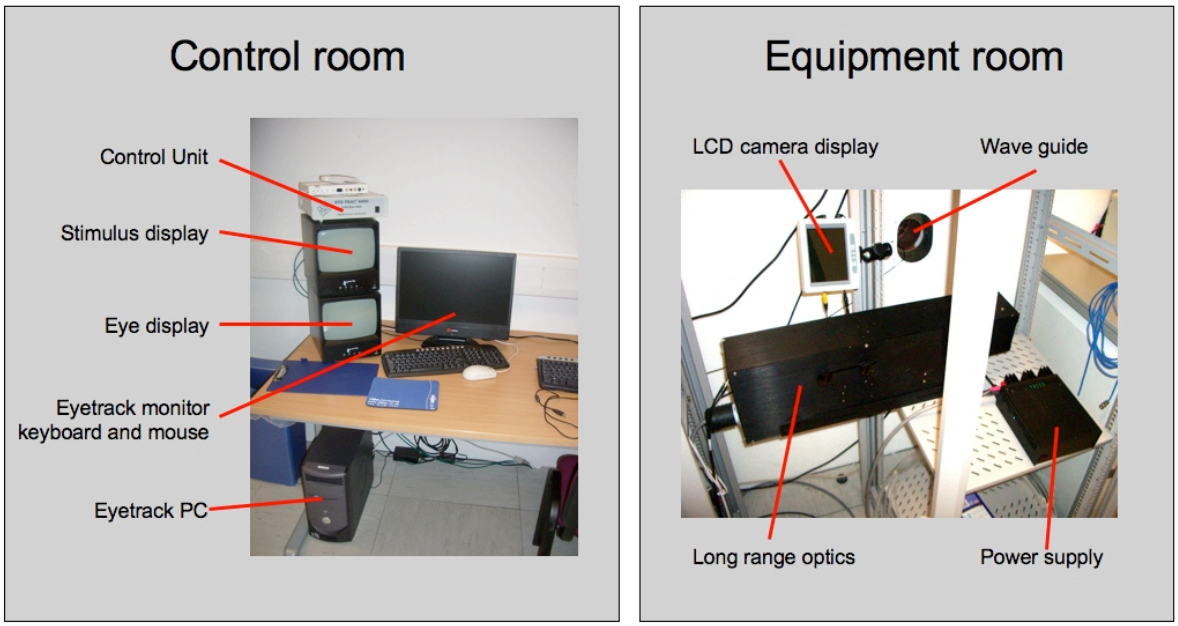
Figure B.2. An Example Reading Path.



The images above show how the eyetracking software 'locks' onto the pupil with a cross hair (Figure B.1). The image in (Figure B.2) shows the x-y output (in pink) of the eye gaze path detected by the eyetracker overlaid onto the stimulus (in this case some German text).

B.2. Components of the Eyetracking system

Figure B.3. Eyetracking Hardware.



The physical hardware for eyetracking consists of multiple parts that are split between the Control room and the Equipment Backroom. An image of the components is shown in (Figure B.3).

B.2.1. Hardware

B.2.1.1. Control Room

Hardware in the Control Room include:

1. **Eyetrack PC, monitor, keyboard and mouse:** This is the control centre for the software that drives the eyetracker itself. This computer and the Eyetrack software on it need to be running when we want to acquire Eyetracking data.

2. **Stimulus display:** this black and white CRT monitor displays a copy of the stimulus output as seen by the participant in the scanner.

3. **Eye display:** this black and white CRT monitor shows the output of the eye camera in the equipment room – the pupil of the eye will show up as a white circle if the camera is focussed and position correctly.

4. **ASL Control Unit:** This is the white box that sits on top of the Stimulus and eye displays. It controls the communication between the PC and the eyetracker optics in the equipment room.

B.2.1.2. Equipment Backroom

Hardware in the Equipment BackRoom include:

1. **Long range optics box:** This box houses a number of components.

    i. **A powerful light source:** this is projected onto the eye to cause the pupil reflection. Of course we don't want a really bright light constantly shining on the participant's eye, so the light is projected through an infrared filter. Hence only infrared light reaches the eye and cannot be physical perceived.

    ii. **A camera to track the eye:** this video camera takes images of the eye at a 50/60Hz frequency. This information is passed out to the LCD camera display (below) and the ASL Control unit and Eye display in the control room.

iii. **Alignment mirrors:** a set of mirrors is used to align the beam of infrared light to the capture path of the camera optics (so that the camera is 'looking where the light is shining' so to speak)

2. **An LCD camera display:** this screen shows the output of the eye camera (in the long range optics box) in the equipment room so that the user can align the camera on the participant's pupil during setup.

3. **A power supply:** the power supply to the long range optics box and LCD screen.

B.2.2. Software

All software controlling this system is housed on the Eyetrack PC in the control room. The software package used is called Eyetrack 6000 and is launched from the Eyetrack PC in the control room.

B.3. Usage of the Eyetracking system

It is CRUCIAL that you follow the startup instructions in this sequence or you may damage the equipment!

B.3.1. Setting up the Hardware and Software

The set up will begin in the Control Room:

1. Start the Eyetrack PC and turn on the PC monitor.

2. Turn on the ASL Control Unit.

3. Turn on the Stimulus Display.

4. Turn on the Eye Display.

   Go to the Equipment Backroom.

5. Turn on the power supply.

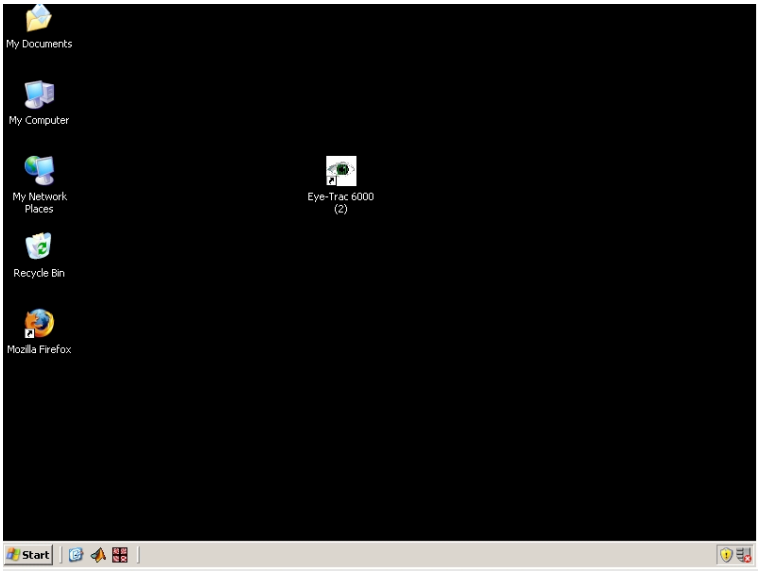
6. Turn on the power switch on the long range optics box (Figure B.4).

Figure B.4. Long Range Optics Box

   Go to the Control Room.

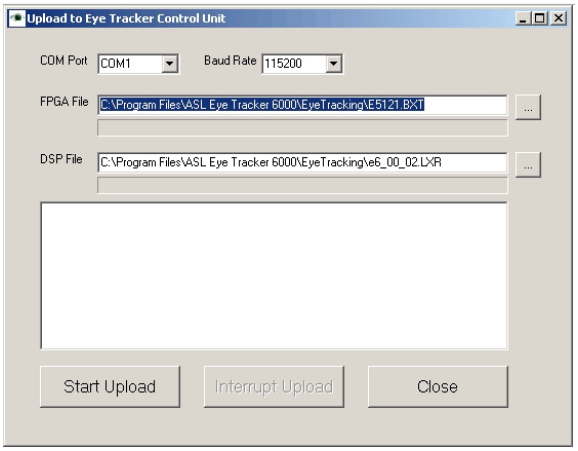
7. Start the Eye-trac 6000 software package by double clicking the software shortcut on the Desktop.

Figure B.5. Eye-trac 6000 Software Shortcut.



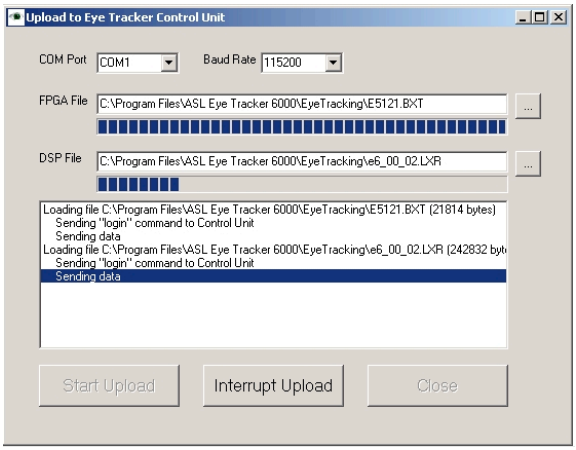
8. Click the Start Upload button.

Figure B.6. Eye-trac 6000 'Start Upload'.



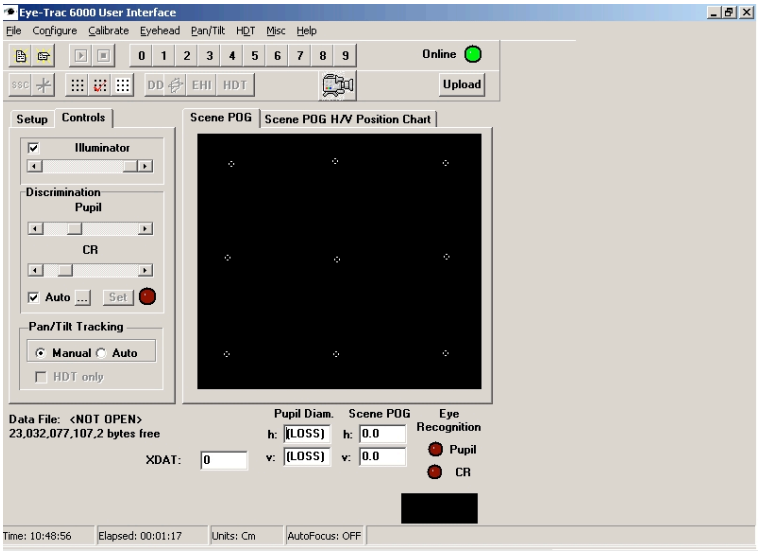
9. Wait for the Control unit to connect to the camera.

Figure B.7. Eye-trac 6000 'Connecting to Camera'.



10. The main software interface will launch.

Figure B.8. Eye-trac 6000 Software Interface.



You now need to set up the participant.

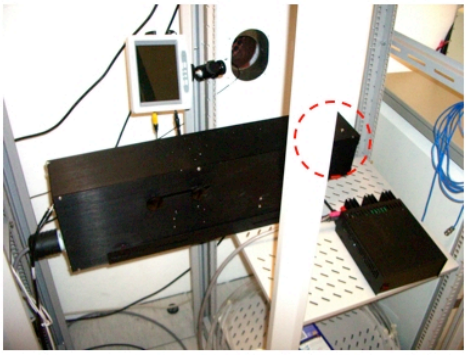
B.3.2. Setting Up the Participant

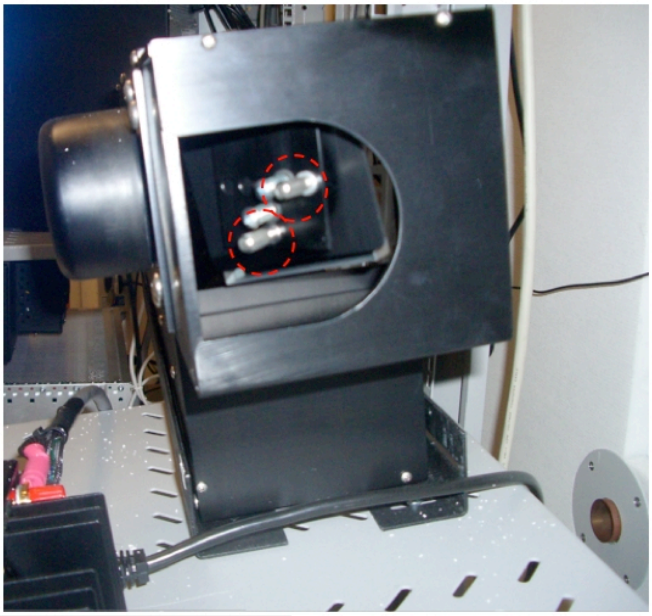
Before you prepare the participant for eye-tracking, ensure that they have suitably prepared and briefed, see (Section 7.1 Participant Preparation, in Section 7.1 Scanning, Experimental Procedures).

1. Place the participant in the MEG seat with the dewar set to the seated position.
2. Raise the participant so the their eyes are just below the dewar rim and ask them to settle.

   Go to the Equipment Backroom.
3. Look at the LCD eye display above the long range optics box.
4. The pupil should be visible as a white dot.
5. Use the alignment dials on the right hand side of the long range optics box to fine tune the alignment trying to make the pupil sit in the centre of the LCD Display. THESE DIALS ARE VERY SENSITIVE SO ONLY SMALL ADJUSTMENTS ARE REQUIRED.

Figure B.9. Long Range Optics Box Alignment Dials





6. Once aligned, adjust the focus with the focus adjuster on the back of the long range optics box.

   Go to the Eyetrack PC in the control room.

7. Check that the cross hair is tracking the pupil in the Eye Display.

8. Once the cross hair is tracking the pupil in the Eye Display, you are now ready to begin acquiring. Follow the normal MEG operation routine.

9. Ensure that you are using an acquisition protocol that is set up to acquire External Channels 91 and 92.

B.4. Eyetracking Troubleshooting Guide

1. **LCD Eye display is not showing any image.**

   i. Check the power supply is on.

   ii. Check the power switch on the Long range optics box is also turned on.

2. **Eyetrack 6000 software won't complete upload.**

   i. Check the control unit is on.

   ii. Check the power supply is on.

   iii. Check the power switch on the Long range optics box is also turned on.

3. **All power is on but no pupil appears in the LCD eye display.**

   i. Check participant position.

   ii. Try small adjustments with the alignment dials.

Appendix C. EOG/ECG Setup

The MEG system is capable of accepting up to 96 channels of concurrent EEG data for analysis and display with MEG data. During the acquisition session, EEG and MEG data are collected simultaneously. For this purpose, the scan acquisition must be setup to acquire the signal from the relevant EEG channels (E1-96).

C.1. Components of the EEG System.

C.1.1. Hardware

In the Control Room:

1. **EEG PC Monitor.**

2. **EEG leads / electrodes.** Labeled EOG / ECG electrodes can be found in the top drawer underneath the MEG Preparation table. More electrodes, EEG caps and consumables can be found in the MEG storage cabinet “1”.

In the MSR:

- **EEG Headbox (x3).** These are the jack boxes where the electrodes are plugged. Each Head Box consist of 32 channels.

In the Equipment Backroom:

1. **EEG PC.**

2. **SynAmp System Unit (x3).**The System Units transmit the data to the EEG computer.

3. **SynAmp Power Unit (x1).**

C.1.2. Software

The software package used is called SCAN 4.3 “Acquire” and is hosted in the EEG-PC. The SCAN Acquire software serves as the interface to the SynAmps.

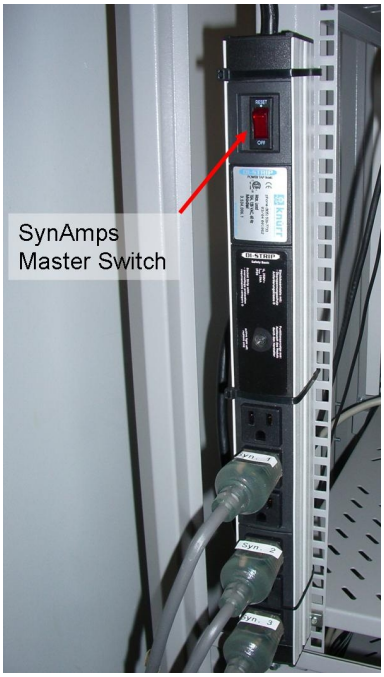
C.2. Using the EEG System to Record EOG and ECG

Attention: *It is important to follow the steps on this section in sequential order.*

Start in the Equipment Backroom:

1. Switch ON the SynAmp units. This is done with a single master switch located on the EEG rack, see Figure C.1.

Figure C.1. EEG SynAmp Switch



2. Wait until the LED screen is on, the three SynAmps are ON, and they read SYN 1,2,3.

3. Turn on the EEG PC.
   Go to the Control Room

4. Login on the EEG PC.

5. Start the Scan 4.3 Acquire program. This shortcut to the program in Figure C.2 is on the desktop.

Figure C.2. EEG Software Launch Graphic

6. Click on the “Play” icon. The main Acquire window will appear.

7. Select the appropiate configuration file:

   a. Click “Load Setup” under File, and browse until you find the correct setup file for your experiment.

   b. For EOG/ECG recordings, select “EOGECG50Hz.ast”.

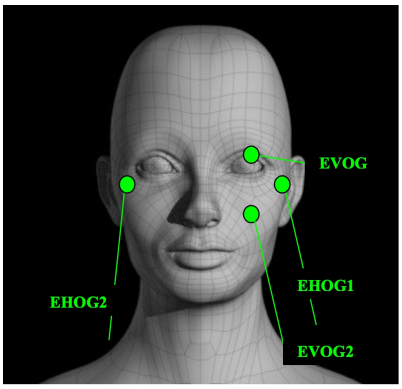
C.3. Participant Setup

The EEG electrodes(i.e., EOG and ECG) must be placed prior to positioning the participant in the MEG Sensor. This procedure can be carried out during the placement of the MEG head localization coils; prior to digitization.

C.3.1. Electroculogram (EOG) Eye Lead Placement

These are used to identify and monitor eye blinks and saccadic eye movement.

Figure C.3. EOG Leads



EVOG – Left Eye only. Place electrodes on the **orbital ridge** centred directly above and below the left eye.

EHOG – Left and Right Eye. Place electrodes at the **lateral junction** of the upper and lower eyes lid.

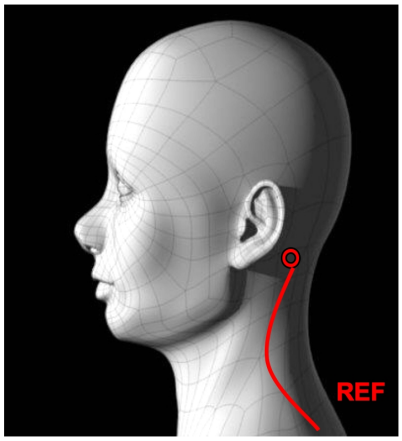
Place electrodes as close as possible to the eye without causing discomfort.

1. Clean the skin on the cheek near the eyes.
2. Attach Large Adhesive Tape (Micropore) to the electrodes.
3. Apply Electrolyte Gel through the electrode opening.
4. Place the electrodes.
5. Press the electrodes onto skin.
6. Check the impedances.
7. Secure with tape.

C.3.2. Reference Electrode / Mastoid Placement

This is used to define the electronics common point.

Figure C.4. ECG Reference Lead Placement



Left Mastoid Reference. , Place the electrode on the **left mastoid**; which is the bony prominence behind the left ear.

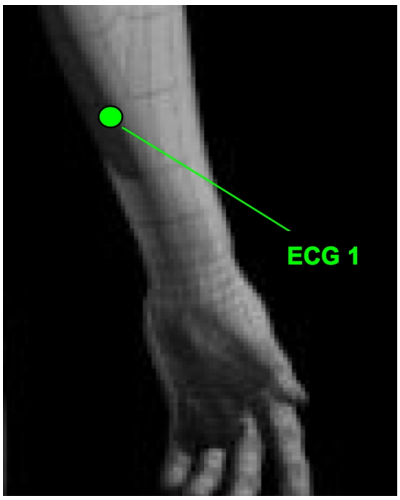
1. Clean the skin behind the left ear.

2. Attach Adhesive Tape (Micropore) to the superior side of the electrodes.
3. Apply Electrolyte Gel through the electrode opening.
4. Press the electrodes onto the skin.
5. Check the impedances.
6. Secure with tape.

C.3.3. Electrocardiogram (ECG) Arm Lead Placement

These are used to identify and represent the heart's electrical activity.

Figure C.5. ECG Leads



The Left and Right Arm ECG leads are placed on the **left and right anterior forearms**.

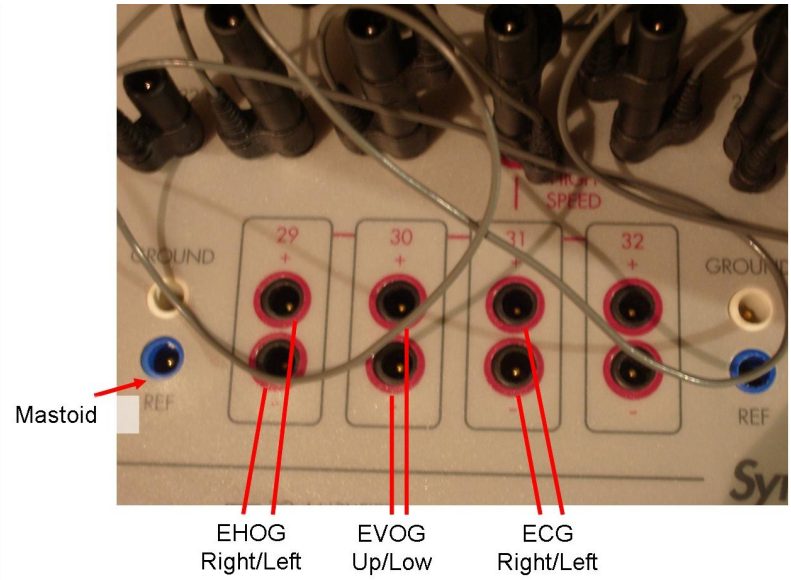
1. Clean the skin behind the left and right inner arm.
2. Attach Adhesive Tape (Micropore) to the superior side of the electrodes.
3. Apply Electrolyte Gel through the electrode opening.
4. Place the electrodes onto the skin:
    a. The negative (ECG1) electrode on the left arm.
    b. The positive (ECG2) electrode on the right arm.
5. Check the impedances.
6. Secure with tape.

C.3.4. Connections on the Electrode HeadBox

Electrode	***Jack Location***
Mastoids	Ref position (red)
EHOG - Left / Right Outer Canthus	Bipolar EEG Channel 29
EVOG - Supra-Infra Orbital	Bipolar EEG Channel 30
ECG - Left/Right Arm	Bipolar EEG Channel 31

1. EHOG Plug into a bipolar channel.
2. EVOG Plug into a bipolar channel.
3. Plug the Mastoids into a Linked Electrode Adaptor (Y Connector) then place the single end of the adaptor into the Ref (red) position to link the mastoids together.
4. ECG Plug into bipolar channel 31

Figure C.6. EEG Headbox: Positions Used for EOG/ECG Measurements.



Make sure to plug electrodes in the correct jack box location. Check the montage. Electrode labels on jack box are in the lower right corner of each jack position.

C.4. Check the EOG/ECG Signal

To verify the quality of the EEG signal:

1. Go to the EEG console in the control room.
2. Click on the Play button on the Acquire window. You should see the signal from the three channels. If there is not signal, check that all the Synamps (in the equipment room) are ON . Then restart the EEG PC.

   In the background there will be a message stating "Data not Recording". This is because the data will not be stored on the EEG system, but will be recorded by the MEG system instead.
3. Check that the signal from electrodes is clear:
   a. To verify the EVOG, ask the participant to blink.
   b. To verify the EHOG, ask the participant to move their eyes side-to-side.
4. If the eye movements or the cardiac signal are not being detected, check the following:
   a. The leads are properly plugged to the Head Box.
   b. The paired leads are plugged to the same bipolar channel.
   c. The coils are still attached to the skin.
   d. There is enough conductive gel between the electrode and the skin.

e. There is enough conductive gel between the electrode and the skin.

If all the above checks fail, try changing the position of the coils.

5. If there is electric noise, check the following:

   a. The Mastoid lead is properly plugged to the REF position on the Head Box.

   b. The Mastoid coil is still attached to the skin.

   c. There is enough conductive gel between the electrode and the skin.

C.5. MEG Acquisition Setup

For the MEG and EEG channel to be recorded by the MEG system the acquisition scan template must be set up to acquire External Channels 29-31. Please refer to Chapter 6 (MEG Software Acquisition Setup).

C.6. Clean Up Procedure

C.6.1. Participant Clean Up

1. If applicable, remove the EOG / ECG electrodes.
2. Remove the gel using a paper tissue.
3. Clean the skin with an alcohol-free wipe and rub gently.

C.6.2. Equipment Clean Up

1. Clean the **EOG / EEG electrodes** with paper tissue to remove electrolyte gel.
2. Disinfect the **head localization coils** with alcohol-free wipes.

C.7. Shutting Down the EEG System

When the session is finished:

1. On the EEG console, click on the “Stop” button on the Acquire window
2. Close the Scan program.
3. Turn the EEG computer **OFF**
4. Go to the Equipment Backroom and switch **OFF** the Synamps

Appendix D. Troubleshooting for MEG Operators

Inevitably, from time to time, errors will occur in MEG. This guide is designed to help you deal with these errors yourself, rather than call reception for help. Naturally, this guide is not able to capture all possible things that may go wrong. However, please follow the advice below before calling for help. Particularly as if you do call for help, these are probably the steps that YNiC staff will follow to solve / diagnose the problem!

The guide is split into two sections; general problems that you may identify in the setup period prior to acquisition, and errors that may occur during the acquisition process. At the start of each section is a generic guide about how to solve problems that may occur in the setup period, or acquisition period, respectively. There then follows a list of specific errors in each section. Firstly however, there is an index of errors for each section; should you want to seek assistance for a specific error.

D.1. Errors prior to acquisition

If you do encounter a problem pre-acquisition, the solution to your problem may be in the appropriate section of the Operators Manual. Your first point of call should be the appropriate documentation to the stage of set-up which you are at. However, if you have already consulted these, or the documentation has directed you here, there are solutions for the following problems:

D.1.1. Helium

D.1.1.1. The Helium Alarm is Sounding: (you can hear an intermittent beep from the DAS).

Problem A: The flow meter on top of the MEG dewar has abnormal Helium flow.

Solution A: Call reception, who will call a member of staff. They will remove, and then replace the lid on the MEG helium dewar. This should correct the flow.

D.1.1.2. Hissing Sound from the Helium Dewar Storage Cupboard.

Problem A: There is an excess of pressure in one of the Helium storage dewars.

Solution A: As part of the normal pressure control systems of the helium storage dewars, every now and again the dewars vent some helium gas. So long as there is only the sound of gas being released, and no vapour cloud, this is not a problem.

However, if you see a vapour cloud associated with venting from any of the valves on the dewars, leave MEG immediately and go to reception. Reception will contact a member of staff who will vent the Helium storage dewar. This will release the pressure, and the hissing should cease.

D.1.2. Oxygen

D.1.2.1. The Oxygen Alarm is Sounding: (a loud shrill beep from the oxygen monitor).

Problem A: The oxygen level in the MSR has dropped to a dangerously low level.

Solution A: Leave MEG immediately, and go to reception. Reception will call a member of staff. They will silence the oxygen monitor, and investigate the problem.

D.1.3. Magnetically Shielded Room (MSR)

D.1.3.1. The Door to the MSR won't Open.

Problem A: The pneumatics on the MSR have failed.

Solution A: Should the door to the MSR **not** open when you press the red open button, and the only means of opening the MSR door is with the emergency key, call reception. They will call a member of staff who will reset the door pneumatics on the Pressurised Air Distributor.

D.1.3.2. The Bed is Not Locked Down, and / or the Bed is Not Straight Inside the Rails.

Problem A: The bed has not been correctly locked down last time it was moved.

Solution A: Refer to the documentation in Chapter 4 (MSR - Magnetically Shielded Room), and move the chair back on to the rails.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.4. Trigger and Group Codes

D.1.4.1. The Trigger Line is Not Visible.

There are two potential things to check if the trigger line is not visible:

Problem A: The parallel port values are not set correctly.

Solution A: You need to run the “Parallel Port Reset” program which is on the Stimulus PC Desktop. To run this program, refer to (see Section 5.3, in Chapter 5 Stimulus Delivery and Response Equipment).

Problem B: No / an Inappropriate “Real Time Display” has been selected on the 4D Magnetic Source Imaging software.

Solution B: In the “Acquisition Setup” window, click on “Utilities” and then “Real-Time Display Control”. Choose “SenTest” from the “Choose Exisiting Setup” menu.

If these solutions do not work, please contact reception, who will contact a member of YNiC staff.

D.1.4.2. There are No Triggers on the Trigger Line.

There are two potential things to check if there are no triggers on the trigger line:

Problem A: There is no cable for triggers attached to the DAS.

Solution A: The typical stimulus setup uses the auditory trigger line.

1. Find the BNC cable labelled “auditory trigger / trigger input 1” (it has two stripes of yellow tape on it), and connect it to Channel 1 in the “Trigger Inputs” qandaentry of the DAS.
2. Alternatively, should you be setting up a for a study that has different trigger setting, check that there is the appropriate trigger line into the DAS.

Problem B: If the MOTU sound card has errored, this may cause the trigger line for the parallel port to error.

Solution B: Try to disconnect and then reconnect the BNC cable labelled “auditory trigger / trigger input 1” (it has two stripes of yellow tape on it), to Channel 1 in the “Trigger Inputs” qandaentry of the DAS.

1. If this does not work, then re-start the MOTU sound card, as described in the following qandaentry on auditory stimuli.
2. After restarting the MOTU sound card, you may also have to disconnect / reconnect the BNC trigger line as described above.

If these solutions do not work, please contact reception, who will contact a member of YNiC staff.

D.1.4.3. There are No Group Codes on the Trigger Line.

Problem A: The stimulus presentation software is not sending group codes.

Solution A: Group codes are sent by the stimulus presentation software. If you are not getting any Group codes when you run the stimulus presentation software, then you need to check that you are running the version of the stimulus presentation script that was agreed as the final version at the Protocol Feasibility scan. If for whatever reason the experimenter has changed their stimulus presentation script, then they need to make the suitable modifications to the script to see their Group codes.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.5. Auditory Stimuli

D.1.5.1. No Sound Coming Out of the Etymotics

Problem A: There may be a problem with the amplifier.

Solution A: Firstly, check that there is power supply to the amplifier; there will be a red LED on the power button if there is power to the amplifier.

1. If there is not any power, first try to press the power button on. If this does not work, locate the power lead, and re-connect the amplifier to the mains. N.B. If the power lead is in the socket and there is still no power, you may just need to wiggle / secure it.

2. If there is power, check that the sound level on the amplifier is appropriate, and adjust it accordingly for the study. Each study should have the required amplifier sound level in the Experimental Setup sheet.

Problem B: There may be a problem with the Motu Sound Card.

Solution B: Firstly, check that there is power supply to the sound card. There will be two orange LED's lit on the DIGITAL I/O panel if there is power.

1. If there is not any power, the power may be turned on using the circular switch on the right hand side of the sound card.

2. If this doesn't work the power lead may be loose or unattached. Locate the power lead, and re-connect the amplifier to the mains. N.B. If the power lead is in the socket and there is still no power, you may just need to wiggle / secure it.

3. If there is power, check that the sound card is processing sounds. Play the auditory stimuli, and see if the LED's in channels 1 and 2 in the Analogue Out panel are lighting up. The Analogue Out panel is on the right hand side of the Motu sound card, and the LED's will light up in a scale from red to green depending on sound intensity. If none of the LED's light up, then the sound card may not be communicating with the Stim. PC.

4. If the sound card is not communicating with the Stim. PC, then re-start Windows on the Stim. PC to reset the sound card.

If none of these solutions work, please contact reception, who will contact a member of YNiC staff.

D.1.5.2. There Are No Triggers Associated With the Auditory Stimuli.

Problem A: There is no cable for auditory triggers attached to the DAS.

Solution A: Find the BNC cable labelled “auditory trigger / trigger input 1” (it has two stripes of yellow tape on it), and connect it to Channel 1 in the “Trigger Inputs” qandaentry of the DAS.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.6. Visual Stimuli

D.1.6.1. No Visual Stimuli.

Problem A: There is a problem with the projector.

Solution A: Check there is power to the projector. When you press the power button on the projector, the orange standby button should be on.

1. If there is not any power, locate the power lead, and plug the power cable into the back of the projector, (or plug the power lead into the mains, whichever is the problem connection). The orange standby light will come on when there is power. N.B. If the power lead is in the socket and there is still no power, you may just need to wiggle / secure it.

2. If there is power to the projector, it may be projecting, but not onto the screen. If this is the case you will either need to move the projector or adjust the screen. In all likelihood, it will be the screen that needs adjusting; the projector should not be moved unless necessary.

3. If the projector is not projecting through the waveguide, then obviously, the projector position will need to be corrected. If you move the projector, you must log this in the MEG log book.

4. Finally, if the projector is projecting onto the screen, check the focus of the projector. The focus of the projector may be adjusted using the projectors remote control. Adjust accordingly until the image is sharp.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.6.2. The Projector is Displaying a Blue Screen Which Says “LED projector”.

Problem A: The projector cannot find an input from which to dislay images.

Solution A: Press the “source” button on the projectors remote control.

1. If the projector still does not find an input, check that there is a VGA cable connected to the projector. If it is loose, or un-attached but next to the projector, attempt to re-connect the VGA cable.

2. If there is no cable there, contact reception, who will a member of staff.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.6.3. The Projected Images are Discoloured.

Problem A: The projector is over-heating.

Solution A: The fan behind the projector should always be on when the projector is running. If the fan is not on, turn it on. If the fan is already on, contact reception, who will contact a member of YNiC staff.

D.1.6.4. The Image is Inverted or Flipped.

Problem A: The projector settings have not been reverted after a scan that has used a non-standard display setting.

Solution A: Refer to (see Section 5.1.2, in Chapter 5 Stimulus Delivery and Response Equipment). This qandaentry will tell you how to flip and or invert the image using the projectors remote control.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.1.6.5. The Wrong Image is Being Displayed on the Screen

Problem A: The projector is projecting from a disply that is not the one on the Stimulus PC.

Solution A: A previous study has used stimulus presentation software that is not on the Stimulus PC, and have modified the wiring in the backroom. This will probably have been the CRS system (check if the display on the monitor to the left of the Simulus PC monitor is being projected). The wiring in the backroom will have to be reverted to the default stimulus setup. This should be done by a member of staff. Please contact reception, who will contact a member of YNiC staff.

D.1.7. Computers

D.1.7.1. megmap has Been Turned Off

Problem A: When you go to use megmap, the MEG acquisition machine, it is turned off.

Solution A: The megmap computer needs to be turned on by a member of YNiC staff. Please contact reception, who will contact a member of YNiC staff.

D.1.7.2. The Stimulus PC has Been Turned Off

Problem A: When you go to use the Stimulus PC, it is turned off.

Solution A: Go into the backroom and turn the Stimulus PC. Log on as “Stim User.”

D.2. Errors During Acquisition

Nearly all the errors to occur during acquisition tend to be diagnosed by the software; typically, you are presented with a pop-up error message, that often relates to a hardware fault. In these circumstances, there often isn't a default straightforward one-two-three approach to fix it. You need to get to know the quirks of the scanner hardware. However, often the pattern of problem solving involves first cancelling what you are doing in the software, be it begining to acquire data, or during data acquisition; and then doing a soft DAS reset.

If you are acquiring data, and you need to stop the acquisition, it is essential that you CANCEL rather than QUIT the acquisition. QUITING an acquisition will almost certainly result in a DAS error.

If you ever have to stop a scan whilst there is a participant in the scan suite. **You must always inform the participant via the intercom that the scan has been aborted. Should you need to enter the MSR to solve the problem, you must also inform the participant before doing so.**

There now follows a list of specific errors that have been encountered by operators, and a respective actions that are recommended.

D.2.1. Soft DAS Reset

A soft DAS reset involves going to the DAS in the MEG backroom. To do a soft DAS reset you need to do the following:

1. On the User Interface Panel press the button at the bottom left hand corner labelled “DAS reset”.

2. When you do this, the DAS reboots, and on the Real Time Display in the MEG suite, you will see the system boot-up graphics.

3. Eventually, after a few minutes, whatever was on the Real Time Display prior to the DAS reset, will be re-displayed.

If a soft DAS reset does not fix the problem, then in most, if not all occasions, you will have to call reception. Reception will contact a member of YNiC staff who will try and resolve the problem. Typically, if you have tried a soft DAS reset, the staff member will try a hard DAS reset, which shuts the DAS hardware down; rather than simply reboot it. If you are recording data out of hours, ***and only if a member of YNiC staff has shown you how to do a hard DAS reset****, you may as an operator do a hard DAS reset yourself. However, should you be recording data within working hours (i.e. 09:00 - 17:00 Monday to Friday), or in any way be unsure how to do a hard DAS reset, do not try to do a hard DAS reset yourself.*

D.2.2. Digitisation

D.2.2.1. The Head Rest (Transmitter) Does Not Provide Stable Support for the Participant's Head.

Problem A: The bar into which the head rest slots has not been appropriately tightened.

Solution A: Ask the participant to lean forward. Remove the transmitter, and manually tighten the bar, by turning it away from the dewar. Replace the transmitter, and then proceed with the digitisation.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.2.2. Pop-Up Error Message: "Problem powering ON/OFF Fastrak Unit" / "Unable to communicate with Fastrack".

Problem A: The Fastrak digitisation unit is not turned on when you are starting the digitisation process.

Solution A: This error message typically occurs when you click the “Start” button in the Digitize Head Shape window. To solve this, do the following steps.

1. Click “OK” in the Error message window. This will cause the Digitize Head Shape> window to close.
2. Go into the scan suite, and check that the Fastrak is switched on; if it is not on, turn it on.
3. If the Fastrak was already switched on, make sure that all the cable connections on the Fastrak are tight.
4. Once you have either turned the Fastrak on, or checked the cable connections, open a new “Digitize Head Shape” window, and check that the green LED on the Left Hand Side of the Fastrak unit has lit up. The presence of the green light indicates that the Fastrak is now on.
5. If the green LED is lit, re-try clicking the “Start” button, and try to digitise. If the same error message appears, turn the Fastrak off and then on again, and try starting again.
6. Should the green LED not be lit, or should the previous step fail, you should try to do a soft DAS reset.

If these solutions do not work, please contact reception, who will contact a member of YNiC staff.

D.2.2.3. Pop-Up Error Message: "Fastrack Unit Low signal" / "HDSD: Fastrack a Low Signal".

Problem A: The origin of this problem is unkonown, other than it relates to there being a Low Fastrak signal ...

Solution A: This error message typically occurs when you click the “Start” button in the Digitize Head Shape window. Unfortunately, there is no known solution to this error. It has only occured very rarely. The only suggested solution is that you attempt a soft DAS reset.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.2.4. Pop-Up Error Message: "Checksum error in header of existing head shape".

Problem A: The data has not been saved at the end of the digitisation.

Solution A: This error message typically occurs when you have finished digitisation. Unfortunately, the only solution is to repeat the digitisation process.

If this solution do not work, please contact reception, who will contact a member of YNiC staff.

D.2.2.5. Pop-Up Error message: "Unable to power on the Fastrak unit ... received error HDSM: The attempted power up failed".

Problem A: The origin of this problem is unkonown, other than it relates to the Fastrak not being able to be powered on ...

Solution A: This error message typically occurs when you click the “Start” button in the Digitize Head Shape window. Unfortunately, there is no known solution to this error. It has only occured very rarely. The only suggested solution is that you attempt a soft DAS reset.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.3. Acquiring Head Coil Locations

D.2.3.1. High-Frequency Square-Wave Noise in head coil traces on the Real Time Display.

Problem A: The RCS cage has not been pushed back into the correct position before data acquisition.

Solution A: To deal with this problem you will first have to abort your acquisition.

1. When you abort the acquition **do not** verify the head coils and save the data. This data should not be saved.
2. Enter the MSR, inform the participant that the RCS cage needs to be adjusted, and move the RCS cage to the back wall until it clicks into place.
3. Re-start the acquisition as normal.

If this solutions does not work, please contact reception, who will contact a member of YNiC staff.

D.2.3.2. Coil Distances Are Very Large: (i.e. in the order of cm's).

There are two potential things to check if the coil distances are large:

Problem A: Two coils are incorrectly placed on the participants head (i.e. the left coil might be on on the participants right e.t.c.).

Solution A: First, identify from the screen which two coils are in the wrong place.

1. Click the “Cancel” button rather than “Acquire Data” button.
2. Enter the MSR, and swap the two coils that are in the wrong place on coil box that is attached to the MEG gantry.
3. Re-start the acquisition as normal.

Problem B: One of the coils is faulty.

Solution B: You will have to replace the faulty coil. An indication that there is a faulty coil is that 1, 3 or all of the coils have a large error on them.

1. Click the “Cancel” button rather than “Acquire Data” button.
2. Get a new coil from Cabinet 1 in the MEG Scan Suite.
3. Enter the MSR, and replace the faulty coil on the participant head; remembering to plug it into the coil box that is attached to the MEG gantry.
4. Re-digitise the participant, and then proceed with the acquisition as normal.

If these solutions do not work, please contact reception, who will contact a member of YNiC staff.

D.2.3.3. Pop-Up Error Message: "Calc_Coil_Pos: error computing transform".

Problem A: The transform between digitisation and head coil acquisition has failed. The origin of this problem is unknown.

Solution A: This problem is solved by doing a soft DAS reset. Following the soft DAS reset, proceed with the acquisition as normal.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.3.4. Pop-Up Error Message: "A sufficient match was not found within 50002 iterations. Therefore no transform".

Problem A: The transform between digitisation and head coil acquisition has failed. The origin of this problem is unknown.

Solution A: There has only been one instance of this error. The problem was solved by re-digitising the participant.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4. Data Acquisition

Please remember that if you are acquiring data, and you need to stop the acquisition, it is essential that you CANCEL rather than QUIT the acquisition. QUITING an acquisition will almost certainly result in a DAS error.

D.2.4.1. When You Start to Acquire, There Are No Sensor traces on the Real Time Display: (there is only a dark green screen which has helium information displayed within a blue bar at the bottom of the screen).

Problem A: There is no Real Time Display associated the scan.

Solution A: You can deal with this problem **without aborting your acquisition**.

1. In the Acquisition Setup window, right click on “Utilities”.
2. Select “Real-Time Display Control”.
3. Choose “SenYNiC” from the Choose Existing Setup menu.
4. The screen should update, and the default selection channels will appear on the screen.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.2. High-Frequency Noise in Sensor Traces on Real Time Display.

Problem A: The RCS cage has not been pushed back into the correct position before data acquisition.

Solution A: To deal with this problem you will first have to abort your acquisition.

1. When you abort the acquition **do not** verify the head coils and save the data. This data should not be saved.
2. Enter the MSR, inform the participant that the RCS cage needs to be adjusted, and move the RCS cage to the back wall until it clicks into place.
3. Re-start the acquisition as normal.

Problem B: The correct weights, or no weights, have been associated with the scan. There is an error in your scan template.

Solution B: To deal with this problem you will first have to abort your acquisition.

1. In the Acquisition Setup window, right click on “Parameters”.
2. Select “Weights”.
3. Choose the appropriate weights for your scan, e.g.“Seated” or “Supine”.
4. Re-start the acquisition as normal.
5. At the end of the acquisition, you will have to save and re-name the scan template

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.3. Flat Sensor Traces on Real Time Display.

There are two potential things to try if the sensor traces are flat:

Problem A: Unknown: Sometimes this error occurs without any known cause.

Solution A: To deal with this problem you will first have to abort your acquisition.

1. Send the Acquisition as Idle Parameters a few times.
2. After a few Idle Acquisitions, if the channels look normal, try a Data Acquition.
3. If after a few Idle Acquisitions, the Data Acquisition still has flat lines, you need to perform a soft DAS reset.

Problem B: The scan you are recording is not expecting internal triggers, however, an internal trigger line is attached to the User Interface Panel of the DAS.

Solution B: To deal with this problem you will first have to abort your acquisition.

1. Remove the internal trigger line from the User Interface Panel of the DAS
2. Re-start the acquisition as normal.

If these solutions do not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.4. Pop-Up Error Message: "Acquisition in Progress crashed, DAS may not respond and run may be locked".

Problem A: The DAS errors when you stop an acquisition from the Acquisition in Progress window.

Solution A: Click “OK”, and your coil positions should be saved. If you have a second run:

1. When you need to start the second run, click “Start Initialization” even if the Run value has not moved on by one.
2. If the Start Initialization is succesful, the Run value will increase by one in the Acquisition Setup, and you can record the subsequent scan.
3. If none of the above is succesful, do a soft DAS reset without closing the Acquisition Setup window.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.5. Pop-Up Error Message: "Unable to communicate with DAS".

Problem A: The DAS communication fails when you select for a scan to be Sent as Idle Parameters or to Start Initialization.

Solution A: This is a common error. Try to Send as Idle parameters a few times (at least three times). However, if this doesn't work, the only solution is a soft DAS reset. Subsequently, start acquisition as normal.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.6. Pop-Up Error Message: "Fatal Acquisition Error(s). Unable to open communication with DAS(York_96) due to MAP_DCOMM: Incorrect DAS Lock message type!".

Problem A: Cancelling a previous process has caused a temporary communication failure with the DAS. You will temporarily be unable to Start Initialization, or Send as Idle Parameters.

Solution A: Dismiss the error message by clicking “OK”, and wait a couple of minutes before trying to acquire again.

1. If you can't Start Initialization, or Send as Idle Parameters after a few minutes, be patient, it may take a few attempts; typically atleast three attempts.

2. If you've been patient, and tried at least three times unsuccessfully, do a soft DAS reset.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.7. Pop-Up Error Message: "Fatal Error. Data Acquisition".

Problem A: A fatal software error occurs during your acquisition.

Solution A: You will have to perform a soft DAS reset.

1. If a soft DAS reset does not fix the problem, you will have to call reception, who will contact a member of staff. The staff member will then resolve the problem by rebooting megmap. **megmap must only ever be rebooted by a member of YNiC staff.**

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.8. Pop-Up Error Message: "Fatal Acquisition. DCS:DCSM unoperational state".

Problem A: A fatal hardware error occurs during your acquisition.

Solution A: You will have to perform a soft DAS reset.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.9. Pop-Up Error Message: "Fatal Acquisition. ACSM: Error sending M?G to Task(s)".

Problem A: A fatal hardware error occurs during your acquisition.

Solution A: You will have to perform a soft DAS reset.

If this solution does not work, please contact reception, who will contact a member of YNiC staff.

D.2.4.10. Pop-Up Error Message: "Fatal Aqusition Error(s) REID: Timeout from RCG/SCP REC while setting up the hardware for the user acquistion".

Problem A: A fatal hardware error occurs during your acquisition. Most likely it is an error on the DY4 board in the DAS rack.

Solution A: Try a soft DAS reset, although this may well not solve the problem.

1. If a soft DAS reset does not work, please contact reception, who will contact a member of YNiC staff. The YNiC staff member will then do a hard DAS reset.

D.2.4.11. Pop-Up Error Message: "PDI Output DMA OTE Overlap Error while performing 'TDET': Error trying to insert output DMA function".

Problem A: A fatal hardware error occurs during your acquisition.

Solution A: Try a soft DAS reset, although this may well not solve the problem.

1. If a soft DAS reset does not work, please contact reception, who will contact a member of YNiC staff. The YNiC staff member will then do a hard DAS reset.

D.2.5. Data Transfer

D.2.5.1. Pop-Up Error message: "Other processes using data cannot transfer" (N.B. This is not an exact error message).

Problem A: You have been viewing data in the Data Editor window prior to trying to transfer it nihead002.

Solution A: There is a chance that you may be able to ignore this error and the data will transfer. However, if you it doesn't work, you will have to restart the Magnetic Source Imaging software. This can be done in the following manner:

1. Un-post all participants in the database.

2. Close the Magnetic Source Imaging database.

3. Right click on the desktop and re-open the Magnetic Source Imaging database.

4. Re-post the data which you want to transfer.

5. Re-attempt to transfer the data. This time the data should successfully transfer.

If this solutions does not work, please contact reception, who will contact a member of YNiC staff.

Appendix E. MEG Wiring Diagram

The layout of the Equipment Backroom is detailed in Figure E.1, and a wiring diagram of the Stimulus Rack is detailed in Figure E.2. There then follows a series of reference images of items of equipment from the backroom. These are here to complement the wiring diagram.

Figure E.1. MEG Equipment Backroom Diagram.

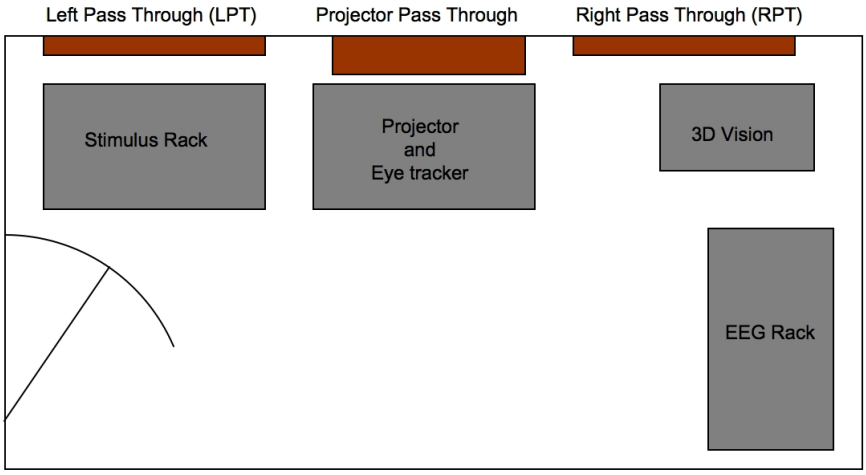


Figure E.2. MEG Equipment Backroom Wiring Diagram.

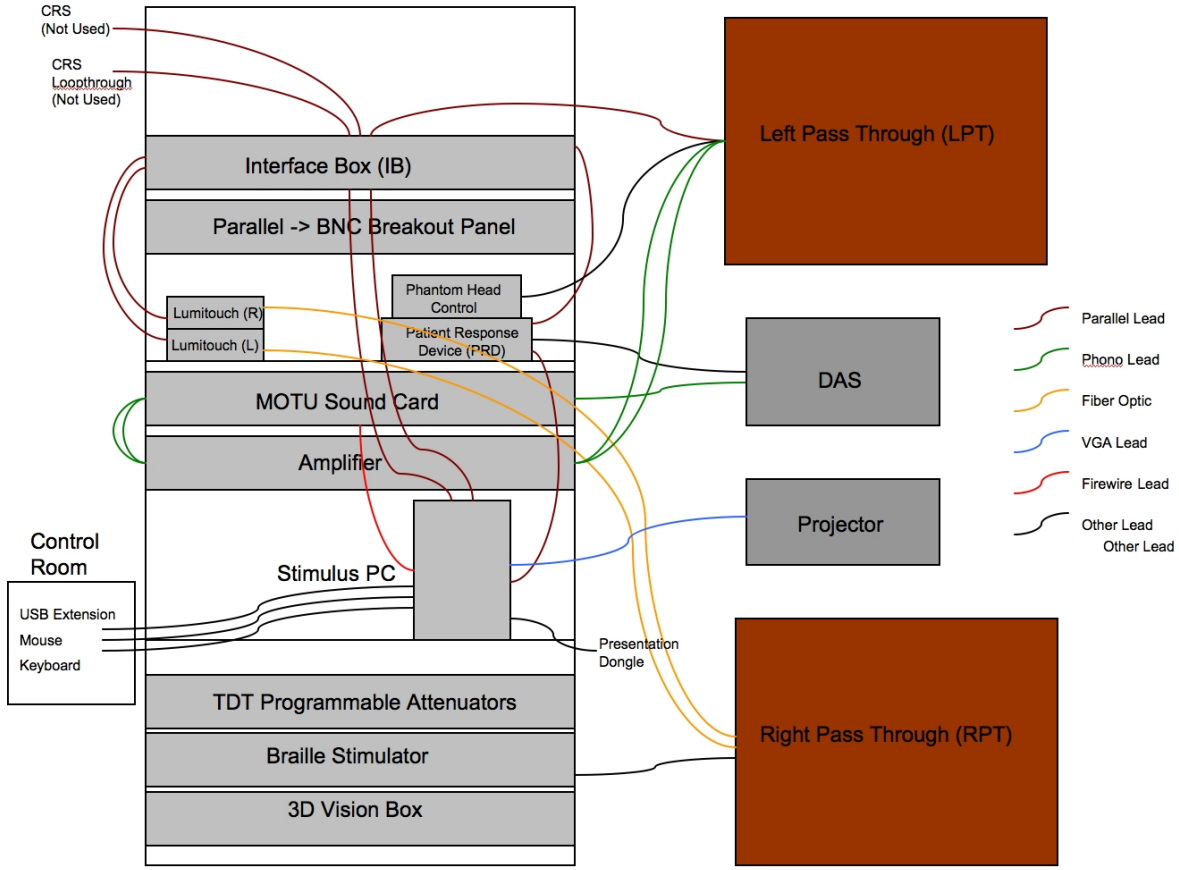


Figure E.3. MEG DAS User Interface Panel Schematic.

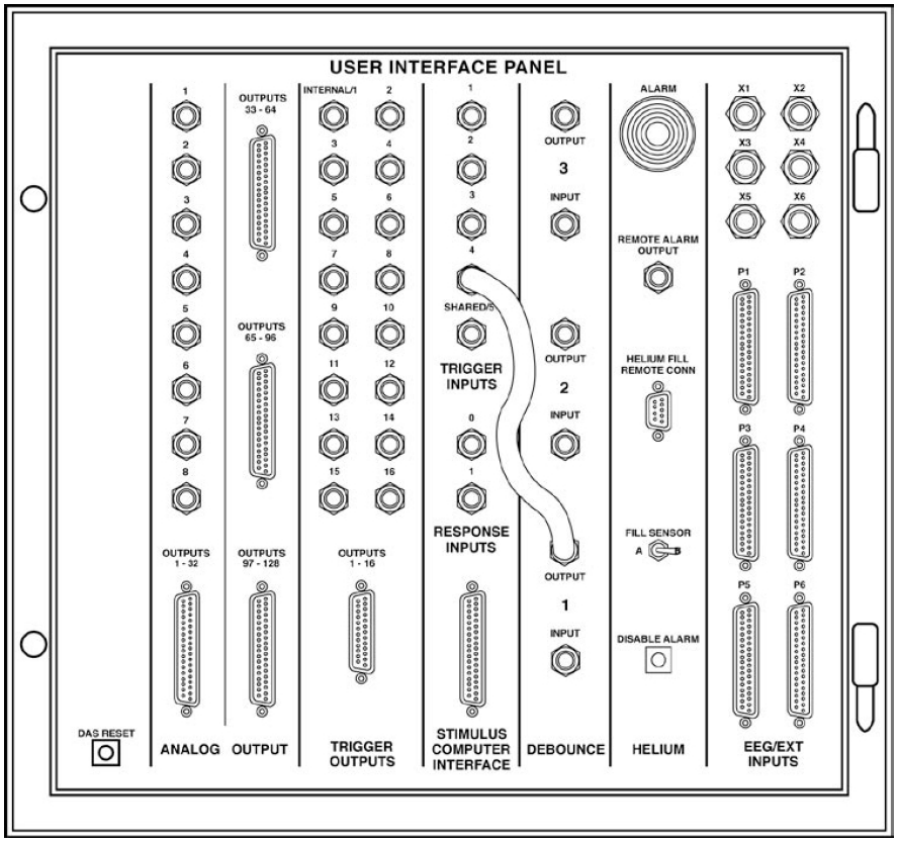
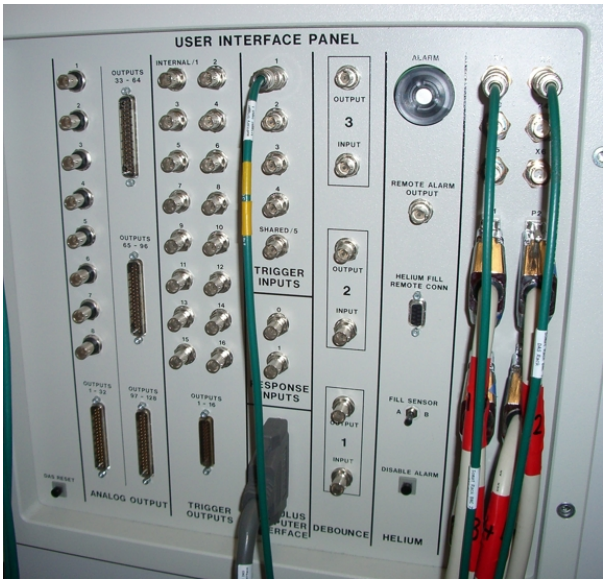


Figure E.4. MEG DAS User Interface Panel.



On image Figure E.4, the Green BNC connected to Trigger Input 1 (top middle), is from the MOTU sound card. The 2 green BNCs at the top right of the image are from the eye-tracker. The parallel cables at the bottom right are from the EEG. And the grey parallel cable at the bottom middle of the image is from the Interface box.

Figure E.5. MEG Stimulus Rack Interface Box (Front).

Figure E.6. MEG Stimulus Rack Interface Box (Back).

Figure E.7. MEG Lumitouch Control (Front).

Figure E.8. MEG Lumitouch Control (Back).

Figure E.9. MEG Phantom Head Control (Front).

Figure E.10. MEG Patient Response Device (Front).

Figure E.11. MEG Phantom Head Control and Patient Response Device (Back).

Figure E.12. MEG MOTU and Amplifier (Front).

Figure E.13. MEG MOTU and Amplifier (Back pt1.).

Figure E.14. MEG MOTU and Amplifier (Back pt2.).

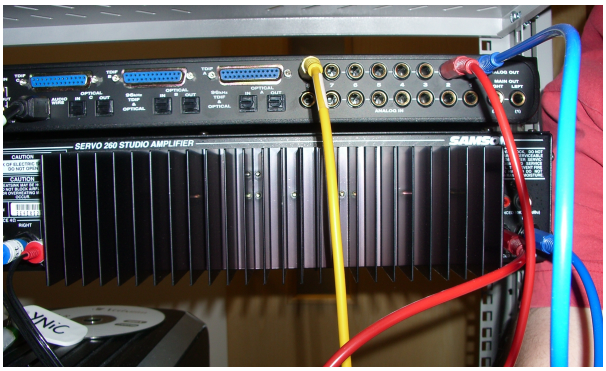


Figure E.15. MEG Visual Projector (Top): The Control Panel and Power Switch.

Figure E.16. MEG Visual Projector (Top): The Control Panel and Power Switch.

Figure E.17. MEG Braille Stimulator (Front).

Figure E.18. MEG Somatosensory Unit (Front): With IR Camera Swtich.